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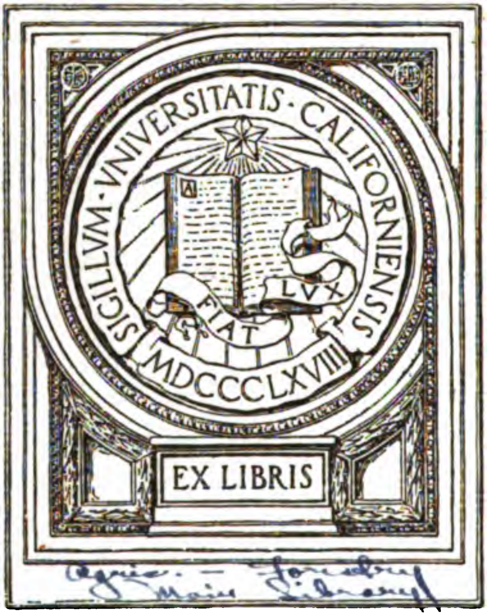

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The Cost of Growing Timber in the Pacific Northwest, as Related to the Interest Rates Available to Various Forest Owners

BY

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THE COST OF GROWING TIMBER IN THE PACIFIC NORTHWEST, AS RELATED TO THE INTEREST RATES AVAILABLE TO VARIOUS FOREST OWNERS

BURT P. KIRKLAND, Associate Professor of Forestry

The cost per acre of growing timber anywhere depends on five main factors, viz. (1) The value of the land, (2) The cost of stocking it with young trees, (3) The administration of the operation and protection of the young timber, (4) The taxes, (5) The rate of interest. The cost per thousand feet depends in addition upon the productivity of the land involved. For the purpose of this discussion, however, the statement may best be put in another way, namely, that the costs per acre are as follows: (1) Interest on the value of the land, (2) The cost of stocking it with young trees, (3) Interest on this amount from time of stocking to maturity, (4) The annual expenses for administration and protection, (5) Interest on each annual expense from time of expenditure to time of maturity of the timber, (6) The annual taxes, (7) Interest on each annual tax from time of payment to maturity of the timber. The total of these costs per acre, divided by the average product per acre gives the cost of producing 1,000 board feet of timber.

The amounts for some of these items vary with natural conditions, and of others, with the ownership of the land. Thus state or federal ownership modifies the element of taxes and changes the rate of interest. Private ownership might facilitate administration in some ways, though it can hardly be expected to reduce the cost, owing to the smaller areas administered. The amounts of the various items under various conditions and forms of ownership are discussed below.

Interest on the Land Value

The cost of cutover lands of supposed agricultural value, or of a nature such that the seller can convince the inexperienced buyer that they have agricultural value would probably run from $10.00 to $50.00 per acre in Washington, where the values are not influenced by proximity to centers of population or other advantages of a similar nature. Hillsides, appearing even to the unpracticed eye too steep for agriculture, may be pur chased for $3.00 to $5.00 per acre. The higher values first mentioned are undoubtedly beyond any present use value of the land for agriculture, but the optimism of the West can be depended upon to maintain them, because the buyer of land has sanguine ideas as to the income to be derived. If the land is to be used for forestry we must concede that current values must be met. Land which is held at over $10.00 per acre should have agricultural value, and for the present at least, should be considered in that class and no attempt made to use it for forestry. The writer, therefore, believes that in Washington fair values for forest soil would be $10.00 per acre for Quality I, $5.00 for Quality II, and $2.00 for Quality III, referring to three quality yield tables for Douglas fir prepared by the U. S. Forest Service.* These tables classify quality of soil for forest purposes according to its actual productivity. In growing timber it must be remembered that the soil is not used up by the growth of the timber. The charge against the growing timber for one rotation, or single crop, is therefore not the soil value, but only the interest on that value for the term of years it takes the timber to grow. Since the timber is not an annual product, the interest cannot be secured annually, but must accumulate until the timber is cut. Hence compound interest is used. What this will amount to at rates applicable to forestry will be discussed later, and shown specifically in the tables forming part of this discussion.

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*These yield tables, prepared by E. J. Hanzlik of the U. S. Forest Service are as yet only in manuscript form. (See page 5.)

Cost of Stocking Land With Trees

While space is not here available to take up in detail the cost of stocking the land, there is good evidence that $5.00 per acre is a fair average figure. Although planting on a bare area will cost nearer $10.00, few areas need be chosen which do not bear some young growth or contain some seed trees which will assist artificial regeneration. Areas that have not been cut over can seldom be stocked any cheaper by natural regeneration than by planting, since the value of the seed trees that must be left will usually bring the cost up to the average figure mentioned above unless there are an unusually large number of worthless trees of the desired species which may be used as seed trees. A skillful combination of planting with natural regeneration from stands not yet cut, and artificial regeneration by planting or seeding should bring the operation within this cost.

Unlike the land cost, the expense of stocking the land with trees has to be repeated every time the timber is cut. This amount must, therefore, be charged against the product of each planting.

Interest on Cost of Stocking Land

The interest on the cost of stocking the land might have been included with the foregoing item, but it is here treated separately in order that all interest charges under various kinds of ownership may be segregated. As in the case of interest on the land value, compound interest must be used. The amount of this item at various rates will be shown specifically in tables forming part of this discussion.

The Annual Cost of Administration and Protection

Kellogg and Ziegler maintain that the annual cost of administration and protection can be handled for five cents per acre.* An analysis of the actual conditions will show that five cents is not sufficient for safety. It must be remembered that this includes office expense, supervision, fire patrol, patrol against trespass, and all other overhead expenses. Although forest fire insurance is not at present one of the expense charges included in this item, the practicability of insuring forests by an enlargement of the scope of the forest fire protective organizations is such that it is bound to come in the near future. Hence this figure should also be high enough to include forest fire insurance. In the case of the state or the federal government, the losses from fire must be charged to this item. Whatever amount accumulates between planting and cutting a single crop must be charged to that crop. The writer does not therefore, believe that the low figure generally assigned to the annual cost of administration and protection is sufficient, but will assign 20 cents per acre per annum as a reasonable, though entirely sufficient amount. The total first cost, or principal sum of this item per acre charged to a single crop of trees will be the annual charge (20c) multiplied by the number of years the crop takes to grow.

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*"Cost of Growing Timber," by R. S. Kellogg and E. A. Ziegler.

Interest on Administration Costs

Compound interest at the chosen rate on each annual amount from the time it is expended until the timber is cut must be calculated. This may be done by compound interest formulae, or taken from such tables as those in Schenk's "Forest Finance."* The specific amounts under certain conditions will be considered later.

Annual Taxes

The annual taxes is a difficult item to foresee. At present taxes in Washington are all considered under the general property tax (a most unscientific system) averaging perhaps 1 per cent to 2 per cent on the actual value of the property. Since, owing to the urgent need of schools, roads, etc., in a pioneer community, and the absence of improved property, taxes may now be thought to be high. A rate of 1 per cent on the actual value of the property may perhaps be considered a fair figure when the future is to be taken into consideration.

Even if this figure is conceded fair, our difficulties have really just begun because of the changes in value that will take place with time, due to the growth of the stand and to changing land values and stumpage prices, to say nothing of continual changes in assessment methods. The following figures are, however, intended to represent a fair approximation of the values to be expected on Quality I Forest Soil, which, as already stated, is considered to be worth $10.00 per acre.

(1) Up to the 20th year of the stand only the soil value of $10.00 per acre would generally be considered by assessors. During this period the taxes at 1 per cent would be 10 cents per acre.

(2) From the 21st to the 30th years of the stand perhaps $10.00 per acre might be added to the valuation because of the young stand, making taxes 20 cents per acre per annum.

(3) From the 31st to the 40th years of the stand, since it is not yet in the saw timber class, it can best be estimated in cubic feet. It will now contain (on Quality I Soil) 4,000 cubic feet per acre, or about 40 cords, which as pulpwood would be worth, say 50 cents per cord, bringing the total value of land and timber up to $30.00 per acre and the tax to 30 cents per acre per annum during this period.

(4) From the 41st to the 50th years the volume will be about 20,000 ft. B. M. per acre, worth on the average (considering increased stumpage prices in the future) at least $3.00 per M., or $60.00 for the whole stand. Hence soil and timber would be worth $70.00 per acre and the annual tax 70 cents.

(5) From the 51st to the 60th years the stand would contain an average of about 35,000 ft. B. M., with a stumpage value of say $8.00 per M., hence the total value of stand and soil, $290.00, and the annual tax $2.90 per acre.

To recapitulate, the taxes on Quality I Forest Soil by the general property tax are estimated somewhat as follows:

1st to 20th years, 10 cents per acre per annum.
21st to 30th years, 20 cents per acre per annum.
31st to 40th years, 30 cents per acre per annum.
41st to 50th years, 70 cents per acre per annum.
51st to 60th years, 2.90 cents per acre per annum.

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*"Forest Finance," by C. A. Schenk.

Considering the smaller volumes and poorer qualities with the Quality II soil the taxable values would be worth only about two-thirds as much, and with Quality III soil one-third as much; hence taxes may be assumed to be only two-thirds and one-third as much respectively, both as to first cost and interest accumulated. Taxation will be further discussed on the basis of the cost tables forming part of this discussion, after those tables are presented.

Interest on Taxes Under General Property Tax

Compound interest must be computed on the amounts paid in taxes from the time paid until the timber is mature. The specific amounts depend on the interest rates and the age to which timber is held, and will be considered hereafter.

Matters Which Influence the Above Elements of Cost

(a) *Ownership*. The chief classes of forest owners as affecting these elements are the federal government, the state, municipalities, large corporations, small corporations, and individuals. The chief items affected by ownership are:

(b) *Taxes*. The federal government pays 25 per cent of the gross yield directly to the states and expends another 10 per cent on roads, but as the roads are of equal value to the forests only the 25 per cent paid to the states will be considered as a gross yield tax. Lands owned by states and municipalities are also in a sense not subject to tax, but in another sense if we assume that the land would be worked under forest management either publicly or by private owners we may conclude that the state and municipality will lose tax revenue by reason of their land ownership, because of withdrawing lands from taxation, and must therefore make up from their forest revenue the deficit in their general fund as discussed hereafter.

If the federal government and the private owner pay 25 per cent of the gross yield of the forest for taxes, the state and municipality should set aside 25 per cent of the gross forest revenue from stumpage for their general fund. If the municipality is the owner it might be required to pay the state such a part of the 25 per cent set aside as the state's share of the taxes amounts to, and which will otherwise be lost by holding the land in public ownership. If the state were the owner it should pay the municipality, or local taxing body its proper share of the 25 per cent. Of course in practice this system of book-keeping might not be carried out in detail, but in effect it would be, if the practice of forestry proceeded profitably.

(c) *Interest*. This varies more widely with ownership than taxes. The fact that individuals, states, and the nation have to pay different rates is so well known as to need little comment except to name an average rate for each. The writer considers the following a fair average rate for each class of owner:

Federal Government	3	per cent.
State (Washington)	4	per cent.
Municipality	4½	per cent.
Large Corporation	4½ to 5	per cent.
Moderate Sized Corporation	6	per cent.
Small Corporation and Individual	7	per cent.

Naturally no owner will, from the standpoint of financial investment, care to engage in forestry unless he can make as high a per cent on his capital as he will have to pay for borrowed capital, or at which he can lend his money. Hence the above rates will be used in calculations.

(d) *Length of Time Between Planting and Harvest.* This influences the amount to which the interest charges on the various items will accumulate. In previous calculations the writer has found the best available evidence seems to indicate about 60 years as giving the highest profits from the use of the soil for private forestry, while 80 to 100 years is more profitable for government forestry. In order to make a comparison as favorable as possible to private forestry, 60 years is chosen for the length of rotation. Specific costs are figured on this basis using the various interest rates already named.

Influence of Yield Per Acre on Costs Per Thousand Board Feet. Except for the interest on the soil value and the taxes with interest thereon, the foregoing elements of cost per acre will not vary widely on different qualities of soil. It is, of course, common knowledge that the yield on different soil qualities will vary greatly. This variation is even greater than generally supposed. The United States Forest Service has made a careful study of this subject in Western Washington and Oregon, the results of which have unfortunately only in part been published. In this study measurements were taken of stands on a wide variety of soils which were classified into three qualities on the basis of the yields found. Quality I or first quality 44 M. per acre, Quality II or medium quality 32 M. feet per acre and Quality III or poorest quality 16½ M. feet per acre for the same period. Obviously, then, if the cost per acre of growing the timber remains little changed for the different qualities the cost per 1,000 feet B. M. will be much less in the case of large yields, just as would be the case in an agricultural crop. These results are brought out in tables about to follow, in which the yields shown by the U. S. Forest Service study are used as authoritative.

Results of Foregoing Elements Presented in Tabular Form. The definite results of the foregoing elements have been worked out mathematically for each item and are presented in the following tables in order to show their relationships, and make comparisons of different interest rates and tax systems as simple as possible. The itemized and total costs to owners working under different interest rates are presented in a single table for each of the soil qualities already mentioned. Costs on Quality I soil are presented in Table I, on Quality II soil in Table III, and on Quality III soil in Table V. The intervening tables present summaries of those mentioned in which the first costs, the interest charges and the tax costs are segregated and their percentage relations to each other computed.

On Quality II forest soil the costs per acre are reduced slightly owing to lesser soil value, and hence to less taxes due to the lower soil value and the smaller volume of stand of timber. The land is considered worth $5.00 and the taxes to be two-thirds of what they were on Quality I. The yield according to yield tables prepared by the U. S. Forest Service will be 32,000 ft. B. M. per acre at 60 years. The costs will be as shown for different owners in Table I.

Comparing Table III with Table I, it is seen that where interest rates are low, costs per acre are not reduced much below Quality I, but as yield is less the cost per M. is raised, except in the case of 6 per cent and 7 per cent interest rates. Where interest is high, reduction in land

TABLE I.

Estimated average costs per acre and per M. feet B. M. of growing Douglas fir on Quality I, or best quality forest soil, under a 60 year rotation, computed for interest rates securable by various classes of owners.

ITEMS—	Federal Govt.	State	Municipality	Large corporation	Medium sized corporation	Small corporation and individual
Estimated interest rate for various classes of owners	3%	4%	4½%	5%	6%	7%
*Compound interest on $10.00 soil value, 60 years	$ 48.91	$ 95.19	$130.27	$176.79	$319.88	$ 569.48
Cost of stocking land with young trees	5.00	5.00	5.00	5.00	5.00	5.00
Compound interest on cost of stocking	24.46	47.59	65.14	88.40	159.94	284.74
Sum of annual charges for administration and protection (20c per year for 60 years)	12.00	12.00	12.00	12.00	12.00	12.00
**Interest on all amounts spent on administration and protection from time incurred to time of cutting	20.61	35.60	45.90	58.71	94.62	150.71
Taxes under general property tax when owner subject to them	......	....	....	43.00	43.00	43.00
Interest on taxes from time planted to time of cutting timber ...	......	....	....	***52.04	77.40	114.42
Yield tax of 25% on final product	†36.99	†65.13	†86.10	....	....	....
Total per acre	$147.97	$260.51	$344.41	$435.94	$711.84	$1,179.35
Cost per M. when product is 44 M. per acre. The probable yield as shown by U. S. F. S. yield tables	$ 3.37	$ 5.92	$ 7.83	$ 9.91	$ 16.17	$ 26.80

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*See interest table in Schenck's Forest Finance, Column IV.

**See interest table in Schenck's Forest Finance, Column V.

***There are at least two methods of computing compound interest on the taxes. The simplest method for purposes of this discussion is to analyze as follows, using the 5 per cent column in Table I. Consider that from the 1st to the 60th year, 10c per annum is paid for taxes. Referring to an interest table, we find that compounded for 60 years this accumulates to $35.36, including principal and interest. Beginning with the 20th year, an additional 10c per acre is paid for the remainder of the rotation, or 40 years. This amounts to $12.08 during the 40 years. Beginning with the 30th year, another 10c is added to taxes for the remainder of the rotation. This accumulates to $6.64 in the remaining 30 years. Beginning with the 40th year, 40c is added to taxes for the remainder of the rotation. This accumulates to $13.24 in the 20 years. Finally in the 50th year $2.20 more is added to the taxes, which in the 10 years remaining accumulates to $27.72. The total taxes and interest thereon for the rotation amount to $35.36 plus $12.08 plus $6,64 plus $13.24 plus $27.72 equals $95.04, the total accumulated taxes, both principal and interest. Take therefrom $43.00, the principal sums paid, and there remains $52.04, the accumulated interest on the taxes.

†This figure represents the cost to the owner of a 25% yield tax when the various items of cost of production are as shown in the same columns. Since a 25 per cent yield tax takes 25 per cent of the product, it is evident that the cost of the the tax to the owner would be one-fourth of the total cost of production, including taxes. All the costs aside from the yield tax would then amount to three-fourths of the total cost and the yield tax would be one-third of the other costs. It is thus that the cost of the yield tax is computed in these tables, that is to say, one-third of the costs aside from taxes is the cost of the 25 per cent yield tax in each case. In case stumpage sells at more than the cost of production all the profits on 25 per cent of the yield go to the state

TABLE II.

Summary of Table I.

Showing segregation of all first costs and all interest charges and per cents of total costs due each segregation.

ITEMS—	Federal Govt.	% of total due to each item	State	% of total due to each item	Municipality	% of total due to each item	Large corporation	% of total due to each item	Medium sized corporation	% of total due to each item	Small corporation and individual	% of total due to each item
Estimated interest rates for different owners	3%		4%		4½%		5%		6%		7%	
Total first cost per acre of planting and annual charges, except taxes, for 60 years	$ 17.00	12	$ 17.00	6.5	$ 17.00	4.9	$ 17.00	3.9	$ 17.00	2.4	$ 17.00	1.5
Accumulated compound interest on land value. Cost of planting and annual administrative charges per acre for 60 years	93.97	63	178.38	68.5	241.73	70.1	323.90	74.3	574.44	80.7	1,004.93	85.2
First cost of taxes under general property tax for certain owners	......	......	....	......	....	......	43.00	10	43.00	6	43.00	3.6
Accumulated compound interest on tax cost. General property tax	......	......	....	......	......	......	52.04	11.8	77.40	10.9	114.42	9.7
Yield tax of 25% for public ownership	36.99	25	65.13	25	86.10	25	....	......	....	......	....	......
Total cost per acre	$147.96	100	$260.51	100	$344.41	100	$435.94	100	$711.84	100	$1,179.35	100
Cost per M. when product is 44 M. ft. B. M. per acre....	$ 3.37		$ 5.92		$ 7.85		$ 9.91		$ 16.17		$ 26.80	

value brings about a much lessened interest charge so that costs are reduced more than yield. This results in a slightly smaller cost per M. on this Quality of soil.

On Quality III forest soil the costs per acre are again reduced slightly, owing to reductions in soil value and in taxes due to a lower soil value and a smaller stand of timber. The land is considered worth $2.00 and the taxes to be one-third of what they were on Quality I. The yield will be only 16,500 feet per acre at 60 years, according to Douglas fir yield tables by E. J. Hanzlik, of the United States Forest Service. The costs of artificial planting would be increased on Quality III because of the unfavorable soil conditions and also because trees should really be planted thicker. On account of the low yield per acre natural regeneration might be the most profitable.

The costs for different owners are shown in Table V.

TABLE III.

Estimated average costs per acre and per M. ft. B. M. of growing Douglas fir on Quality II or medium quality forest soil under a 60 year rotation, computed for interest rates securable by various classes of owners.

ITEMS—	Federal Govt.	State	Municipality	Large corporation	Medium sized corporation	Small corporation and individual
Estimated interest rate paid by owner........	3%	4%	4½%	5%	6%	7%
Compound interest on estimated soil value ($5.00), 60 years ....$	24.46	$ 47.60	$ 65.14	$ 88.40	$159.94	$284.74
Cost of stocking land with young trees	5.00	5.00	5.00	5.00	5.00	5.00
Compound interest for 60 years on cost of stocking land	24.46	47.60	65.14	88.40	159.94	284.74
Sum of annual charges for administration and protection for 60 years (20c per acre per annum)	12.00	12.00	12.00	12.00	12.00	12.00
Compound interest on all amounts, spent on admininstration and protection from the time incurred to time of cutting	20.61	35.60	45.90	58.71	94.62	150.71
Taxes under general property tax	......	....	....	**28.66	**28.66	**28.66
Interest on Taxes	......	....	....	**34.70	**51.60	**76.28
Yield tax 25% on final product	*28.84	*49.27	*64.39	....	....	....
Total per acre ....$	115.37	$197.07	$257.57	$315.87	$511.76	$842.13
Total cost per M. on basis of 32 M. per acre yield in 60 years ....$	3.61	$ 6.16	$ 8.05	$ 9.87	$ 16.00	$ 26.31

*See foot-note under Table I.

**Since, as stated on page 5, the value of the yield on Quality II soil, though three-fourths as much in quantity, will on account of the smaller sized timber not be more than two-thirds as much in value as the yield on Quality I, the taxes have been assumed to be only two-thirds as great. These figures for both the taxes and the interest thereon have therefore been derived directly from corresponding values in Table I by computing two-thirds of each value there as the correct figure for this table.

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and profits will be made by the owner only on the 75 per cent remaining to him. That is, the figures shown in these tables represent the cost of the tax, but its actual amount will depend on the stumpage values at the time of cutting.

TABLE IV.

Summary of Table III.

Showing segregation of all first costs and all interest charges and per cents of total costs due each segregation.

ITEMS—	Federal Govt.	% of total due to each item	State	% of total due to each item	Municipality	% of total due to each item	Large corporation	% of total due to each item	Medium sized corporation	% of total due to each item	Small corporation and individual	% of total due to each item
Interest rate	3%		4%		4½%		5%		6%		7%	
Total first cost of stocking and annual costs except taxes ..	$ 17.00	15	$ 17.00	8.6	$ 17.00	6.4	$ 17.00	5.4	$ 17.00	3.3	$ 17.00	2
Accumulated compound interest on all amounts invested except taxes	69.53	60	130.80	66.4	176.18	68.6	235.51	74.6	414.51	81	720.19	85.6
First cost taxes under general property tax	......	......	....	......	....	......	28.66	9	28.66	5.6	28.66	3.4
Accumulated compound interest on taxes. General property tax	......	......	....	......	....	......	34.70	11	51.60	10.1	76.28	9
Taxes under 25% yield tax.....	28.84	25	49.27	25	64.39	25	....	......	....	......	....	......
Total cost per acre	$115.37	100	$197.07	100	$257.57	100	$315.87	100	$511.77	100	$842.13	100
Cost per M.	$ 3.61		$ 6.16		$ 8.05		$ 9.87		$ 16.00		$ 26.31	

INFLUENCE OF THINNINGS

On Quality I Soil. Where thinnings are possible the costs may be reduced by utilizing thinnings about the 30th, 40th, and 50th years. Other studies by the writer, based on number, volume, size, etc., of trees per acre shown by Forest Service yield tables, would seem to indicate pretty clearly that on Quality I soil, timber of at least the values indicated in Table VII, may be removed in thinnings where they are utilizable. There is furthermore very little doubt that all thinnings from young stands originated now or hereafter may be utilized because even now demands for pulpwood, ties, and mine timbers are capable of using all of this type of timber within easy reach of transportation.

Tables VII, VIII, and IX show possible deductions from cost due to this source of income, but the data along this line are not as reliable as other cost data because of uncertainty as to the future price of wood.

TABLE V.

Estimated average costs per acre and per M. ft. B. M. of growing Douglas fir on Quality III, or poorest quality, forest soil under a 60 year rotation, computed for interest rates securable by various classes of owners.

ITEMS—	Federal Govt.	State	Municipality	Large corporation	Medium sized corporation	Small corporation and individual
Interest rate	3%	4%	4½%	5%	6%	7%
Compound interest on soil value ($2.00) for 60 years $	9.78	$ 19.03	$ 26.05	$ 35.36	$ 63.96	$113.90
Cost of stocking with young trees	5.00	5.00	5.00	5.00	5.00	5.00
Compound interest on cost of stocking	24.46	47.60	65.14	88.40	159.94	284.74
Sum of annual charges for administration	12.00	12.00	12.00	12.00	12.00	12.00
Compound interest on all amounts spent for administration and protection from time incurred to time of cutting	20.61	35.60	45.90	58.71	94.62	150.71
Taxes under general property tax—when owner is subject to them	......	....	....	**14.33	**14.33	**14.33
Compound interest on taxes	......	....	....	**17.35	**25.80	**38.14
Taxes under 25% yield tax. Final product	*23.95	*39.74	*51.36	....	....	....
Total cost per acre $	95.80	$158.97	$205.45	$231.15	$375.65	$618.82
Total cost per M. on basis of yield, per acre, in 60 years, 16,500 ft. B. M. $	5.80	$ 9.64	$ 12.45	$ 14.01	$ 22.77	$ 37.50

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*See footnote (**), Table I.

**As stated on page 8 the value of the yield on Quality III, or poorest quality forest soil, will not be more than one-third that on Quality I soil, hence the taxes under general property tax may be assumed to be only one-third as great. These figures for both taxes and interest thereon have, therefore, been derived directly from corresponding values in Table I by computing one-third of each value there given as the correct figure for this table.

TABLE VI.

Summary of Table V.

Showing segregations of all first costs and all interest charges and per cents of total costs due to each segregation, on Quality III. Forest Soil.

ITEMS—	Federal Govt.	% of total due to each item	State	% of total due to each item	Municipality	% of total due to each item	Large corporation	% of total due to each item	Medium sized corporation	% of total due to each item	Small corporation and individual	% of total due to each item
Interest rate	3%		4%		4½%		5%		6%		7%	
Total first cost of stocking, and annual charges except taxes, per acre	$ 17.00	17.7	$ 17.00	10.7	$ 17.00	8.3	$ 17.00	7.3	$ 17.00	4.5	$ 17.00	2.7
Accumulated compound interest on all amounts invested except taxes	54.85	57.3	102.23	64.3	137.09	66.7	182.47	79.0	318.52	84.5	549.35	88.9
First cost of taxes under general property tax for certain owners...............	......	......	....	......	....	......	14.33	6.2	14.33	3.1	14.33	2.3
Accumulated compound interest on tax cost; general property tax	......	......	....	......	....	......	17.35	7.5	25.80	7.9	38.14	6.1
Taxes under 25% yield tax.....	23.95	25	39.74	25	51.36	25	....	......	....	......	....	......
Total cost per acre.........$	95.80	100	$158.97	100	$205.45	100	$231.15	100	$375.65	100	$618.82	100
Cost per M. ....$	5.80		$ 9.64		$ 12.45		$ 14.01		$ 22.77		$ 37.50	

On Quality II Soil. The volume of the thinnings to be obtained on Quality II soils may be expected to bear the same proportionate relation to the volume of thinnings on Quality I as their respective total stands, i. e., as 32,000 is to 44,000, or 8 to 11. The thinnings on Quality II soil, however, will be of smaller sizes, hence less valuable. It seems safe therefore, to assume that the total value will not be more than one-half as great. Hence these thinnings will be expected to make only one-half as much from the total costs as on Quality I soil.

The amount to be deducted from the total costs per acre on Quality II soils because of the thinnings may then be determined directly by taking half the values deduced for thinnings and interest on Quality I soils as shown in Table VII. Table VIII shows these amounts per acre and the resulting amounts per M. ft. B. M.

On Quality III Soil. The volume of the thinnings to be expected from the Quality III soils may be determined by proportion just as they were for the Quality II soils. In this case it would be as 16½ is to 44. As a matter of fact, however, the small sizes grown on Quality III soil would greatly lessen the value of the yield from thinnings so that it may be doubted whether this would exceed one-third of the value of Quality I. Assuming it has one-third the value of the Quality I thinnings, the values of thinnings per acre with interest thereon for Quality III may be taken directly as one-third of the corresponding values in Table VII.

TABLE VII.

Possible Deductions From Costs Due to Thinnings—Douglas Fir—Quality I Soil

ITEMS—	Federal Govt.	State	Municipality	Large corporation	Medium sized corporation	Small corporation and individual
Interest rate	3%	4%	4½%	5%	6%	7%
Value of 30th year, thinning—4 cords pulpwood at 50 cents per cord	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.00
Accumulated interest on this value, 30th year to 60th year	2.84	4.48	5.48	6.64	9.48	13.22
40th year thinning—5 cords pulpwood worth $1 per cord stumpage	5.00	5.00	5.00	5.00	5.00	5.00
Accumulated interest for 20 years	4.05	5.95	7.05	8.25	11.03	14.35
50th year thinning—10 cords pulpwood worth $1.00 per cord	10.00	10.00	10.00	10.00	10.00	10.00
Accumulated interest for 10 years	3.40	4.80	5.53	6.29	7.90	9.67
Total amount saved per acre when thinnings are utilized	$ 27.29	$ 32.23	$ 35.06	$ 38.18	$ 45.41	$ 54.24
Amount saved per M. ft. B. M. when final yield is 44 M. per acre	$ .62	$ .75	$ .79	$ .87	$ 1.03	$ 1.23

TABLE VIII.

Possible Savings in Cost Due to Thinnings on Quality II Soil

ITEMS—	Federal Govt.	State	Municipality	Large corporation	Medium sized corporation	Small corporation and individual
Interest rate	3%	4%	4½%	5%	6%	7%
Total amount saved per acre when thinnings are utilized	$ 13.64	$ 16.11	$ 17.53	$ 19.09	$ 22.70	$ 27.12
Amount saved per M. ft. B. M. when final yield is 32 M. per acre	$ .42	$ .50	$ .55	$ .59	$ .71	$ .85

TABLE IX.

Possible Savings on Cost Due to Thinnings on Quality III Forest Soil

ITEMS—	Federal Govt.	State	Municipality	Large corporation	Medium sized corporation	Small corporation and individual
Interest rate	3%	4%	4½%	5%	6%	7%
Total amount saved per acre when thinnings are utilized	$ 9.09	$ 10.74	$ 11.68	$ 12.73	$ 15.14	$ 18.08
Amount saved per M. ft. B. M. when final yield is 16½ M. per acre.......	$ .55	$ .65	$ .70	$ .77	$ .91	$ 1.09

Certain Modifications of Costs

In General: It is believed that the costs given in the preceding tables represent as fair averages of the cost of growing timber by means of good forestry practice as can be given for the conditions on the west side of the Cascades in the Pacific Northwest. It is, however, obvious that average figures, no matter how correct, cannot be applied directly to all individual cases. In so far as the first costs in a specific case are known to be susceptible of modification, the final costs may be enormously modified. For example, it is entirely probable that much land which is already stocked with young growth could at the present time be bought at the rates specified in the tables, thus saving the cost of stocking entirely and perhaps several years' interest on other costs. This would greatly increase the possibilities of profit on the area in question, because in forestry every dollar saved at the beginning of the rotation may mean from $5.00 to $50.00 at the end, according to the interest rate. Likewise land already stocked with timber might be bought below the price specified, in which case, still more could be saved.

Certain owners might save all or portions of other costs, or find them properly chargeable to other lines of business which they conduct. Thus a coal mining company might find it necessary to hold a large area of coal lands, the surface of which is unsuited to agriculture, or other use except forestry. In this case it would be fair to charge all the land value to the coal, thus removing the heavy interest cost on land value from the forestry costs. On Quality I soil this would remove a charge of $4.02 per M. from the cost of producing timber if the company worked with 5 per cent money. This would enable a company of this sort to produce timber as cheaply as the state.

In municipal forestry, a city finding it necessary to own land for watershed protection might practice forestry without charging interest on land value to it, and might also charge a large part of the actual administration cost to the water department because sanitary patrol is necessary anyway. This would reduce the cost of raising timber to a city below the average cost shown by the federal government, and make the industry one of great direct financial benefit.

When it is remembered that the logging and manufacture of this timber means that upwards of $8.00 is paid out in wages for every thousand feet of timber manufactured, and that the city consumer may as a result of the local timber supply get the manufactured product cheaper, where the city already owns its watershed, no other argument for city forestry is necessary. To put the case in another way, it may be stated that since the average acre of forest soil will in this region produce about 500 feet of timber per annum, any city which practices forestry will for the average acre thus kept in forest produce raw material which will some time insure the payment of $4.00 or more in wages for each year the land is kept producing forests. One hundred and fifty acres kept in forest will support at least the equivalent of one laborer and his family permanently, besides paying a handsome profit to the city. Municipal forests of this type are common in Europe, where profits as high as $12.00 per acre per annum are now made. Of course, no such profit is possible at present in this country, but America is already well on the road to this condition.

Large Corporations

The large corporation can practice forestry because of its low interest rate and the economies in administration and protection due to the ownership of large areas. Where it has holdings in several localities its fire losses will not exceed the average losses of the community, so it will be cheaper for it to carry its own insurance than to pay premiums to a forest fire insurance company, even when the time comes that forest fire insurance is available. Even a heavy fire loss would not cause a correspondingly heavy immediate expenditure, as when a mill is destroyed, but would be made up gradually in growing a new crop. In spite of these facts the large corporation is not yet convinced that forest production would be profitable for it, although a study of the question gives convincing indications that it would be so, especially in the case of corporations which desired to make their life, and hence their investments, perpetual. However, the present political efforts looking toward the destruction of all large business enterprises may result in disintegrating these corporations so that their efficiency and command of capital will be so decreased as to put them out of the class which might practice forestry successfully. Until these political questions are settled, therefore, it would probably be unwise for the large corporation to engage in an enterprise involving a continuous policy for so long a time as is required in forest production.

Railroad corporations not being so subject to this destructive action by government, because the problem of handling these natural monopolies is largely settled, do not labor under this latter disadvantage, though possessed of the other advantages of large corporations. They have also at least three additional advantages which would make it profitable to engage in forest production on lands already owned. The first is that they are large consumers, and the cheapest possible supply of timber is of enormous importance to their construction and maintenance departments. The second follows from this that since they are large consumers practically all selling costs would be saved to their forestry departments. The third reason lies in the fact that the railroad depends on adjacent territory for tonnage. Land adapted only to forestry will yield little tonnage any other way, but as already stated in the case of the municipality, in this region such land will under forest management yield at least 500 feet B. M. per annum on the average. This, then, means to the railroad that every acre kept under management will some time yield 500 feet of lumber, or from 1,500 to 2,000 lbs. of freight for each year that the forest crop is maintained. If this lumber should be shipped to the middle west it means a gross revenue to the railroad of perhaps $5.00 or more per acre per annum, for transportation only.

The Small Owner—The writer believes that the forester can seldom advise the small owner, either corporate or individual, to practice forestry except in the case of the farm woodlot owner. The farmer consumes most of the product of his own forest, thus saving all selling costs, middleman's profits, and transportation to a distance. What he does not consume goes to his neighbor. To this strong economic position as to markets may be added several other advantages. Protection and administration costs nearly disappear because the farm woodlot is generally in sight of the residence and fields, and is surrounded by clearings, hence patrol is unnecessary and fires seldom will occur. Because of the small cutting areas necessary in the farm woodlot, reproduction will in nearly every case come naturally, without extra expense, providing grazing is properly restricted. Finally, though the farmer pays high interest rates when he borrows, he works principally on his own capital, on which he makes a very low rate as a rule. Hence in most cases his forest investment really comes in the low interest rate class.

These advantages place him in the best position of any private owner and the large product of farm woodlots in this country as compared with the National Forests indicate that their economic position is much stronger than the latter. Cuttings can be carried on annually in the farm woodlot in most cases, thus resulting in an annual income from it, and also in the most complete utilization, because windfalls and trees otherwise damaged can be utilized before they decay. Some of these advantages will not be realizable until the pioneer stage is passed, but this will undoubtedly pass with great rapidity in this state because of the many natural advantages it possesses for the settler.

In spite of the great possibilities of the farm woodlot, full production is not likely to be realized unless some technical advice is available. Practically all governments have found it expedient to furnish this at government expense. This is now being done in the Eastern United States, and should be strongly recommended here. It may seem premature to take up such work at the present stage of farm development in Washington, but as a matter of fact, large farm areas are bound to suffer in the not distant future for want of timber because its obvious abundance led to the cutting of every tree for lumber. The down timber will disappear within a short ime and leave no timber available on many farms, or at a convenient distance from them. Moreover, a farm woodlot may usually be established in a recently logged off area at no expense, while later, when all young growth has been destroyed, planting would be necessary.

It is, of course, obvious that if any owner can make forestry pay one per cent or more over the rate at which he can borrow money, he can on his own capital make two per cent or more above the interest rate at which he can borrow. For example, if a corporation can make capital invested in forestry yield six per cent and can borrow at five per cent, it can carry on an operation by borrowing 50 per cent of the capital required at five per cent and carrying the other 50 per cent by funds received originally from sale of stock. Since all the capital yields 6 per cent, while only 5 per cent interest is paid on half of it, the other half will receive 7 per cent. If it borrows two-thirds of its capital at 5 per cent, the remaining one-third receives 8 per cent dividends. In the same way if a state can make capital it uses in this way yield 6 per cent, though borrowed on 4 per cent bonds, the portion of its capital coming from its general fund would yield 10 per cent, i. e., 6 per cent earned by the general fund proposition itself, and 2 per cent additional from each of the thirds coming from bonds. By using its general credit the state could borrow all the funds on 4 per cent bonds and make 2 per cent on all capital borrowed without advancing a cent from its general fund. Or it may prefer to let its citizens have the wood products at cost and neither make nor lose money.

*Taxes as an Element in Cost of Producing Timber**

It should be noted first of all that taxes do not, as sometimes stated, make up the chief cost of the production of timber. They are in fact rather a minor charge, though undoubtedly making up a larger proportion of the cost of production than in some other industries. Mr. J. W. Brislawn, of the State Tax Commission, stated before the tax conference at the University of Washington, May, 1912, that the farmer pays approximately 6.43 per cent of his gross earnings for taxes.** Referring to Tables II, IV, and VI, it may be seen that the first cost of taxes under the general property tax amounts to from 3 per cent to 10 per cent of the cost of producing timber, hence not differing widely from taxes in agriculture. However, so far as the owner is concerned, the actual cost to him is more than twice as great because of the interest charges which accumulate on the tax payments before the timber crop can be harvested.

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*Many foresters in computing cost of growing timber, have treated taxes under the general property tax as an average sum paid annually throughout the life of a single crop. This introduces gross inaccuracy into the calculation of the interest charge on the taxes, making the taxes and interest thereon appear to be far greater than is the case in practice. This may account for the widespread idea that taxes are the chief cost in growing timber. A specific example as to what the effect of this method would be in the present computation is as follows:

The total first cost of taxation on Quality I soil in 60 years, as shown in Table I, on the basis of the tax estimates on page 6, is $43.00. By the method of averaging the general property tax over the entire time of growing a crop this would amount to an average of 72 cents per acre per annum. Referring to interest tables we find that with 6 per cent interest $1.00 paid annually and placed at interest for 60 years amounts to $533.14 by the end of the period. Seventy-two cents paid annually would, therefore, amount to .72x$533.14 equals $383.86, total accumulated sum, both principal and interest. Deduct $43.00, the principal, and we have left $340.86, the accumulated interest. Compare this with $77.40, the accumulated interest at 6 per cent when it is computed on the general property tax sums more nearly according to their actual incidence and the difference is striking. It is so great in fact as to make taxes together with interest thereon, appear as one of the most important costs in forestry, when such is not the case.

If the taxes were deferred until the crop is harvested it would be of advantage to the owner without an entirely corresponding loss to the state which works under a lower interest rate. A yield tax at the time of cutting, greater in the aggregate than the present general property tax, in fact large enough to entirely reimburse the state for the deferred payment, would be advantageous to the producer of timber.

Should the producer of timber be subjected to a yield tax it would need to be placed at much less than 25 per cent of the gross yield or it would cost the owner far more than the present system, interest included. By referring to the 6 per cent column in Table I, it may be seen that the amount of the general property tax and interest thereon is $120.40. If a 25 per cent yield tax were computed, as in the 3 per cent to 4½ per cent columns, it would cost the owner $163.81, a much greater amount than the present system. The main advantage of the yield tax then, unless the percentage were reduced, would be that it could be met easier when the timber was cut. This would be no great advantage except to owners who managed forests under intermittent yield, a poor system, and one not apt to be maintained by any owner. A properly managed tract will give a yield annually from some part of the tract. Hence this system is not considered by the writer to be of much value, unless the percentage of the yield taken were reduced much below that now paid by the federal government. Therefore, the state cannot hope to secure anything like the tax revenue from private lands in forest as it now secures from the National Forests; or rather as it will secure when cutting is in full force in the National Forests.

In this connection it should be emphasized that, as a matter of fact, it is a fallacy to assume that even the state can practice forestry without paying a tax. The presence of the utilized forest means people. People mean taxes for schools, roads, and general expenses of government. Hence the state must spend money for the ordinary purposes for which taxes are expended. If it does not take this money from its forest revenue it must come from general revenue. Hence in effect if the state undertakes to own productive property it must pay taxes which the private owner would have paid had the resource remained in private ownership. Since the state is an aggregation of citizens mostly taxpayers in some form, payment of these expenses out of general funds by the state is the same as paying a tax by the citizens.

**See p. 40. Taxation in Washington, University of Washington Extension Series No. 12.

Necessity for Securing Capital for Forest Production in the State of Washington

Production of timber, it appears from the foregoing, is mainly a question of the investment of capital either by the nation, state, individual, or some other owner. Those owners who must pay or can get high interest rates for the use of capital cannot wisely undertake the production of timber as an investment, even if they were content with such long term investments, which is seldom the case. High priced capital means high cost of growing timber even more strongly than it means high cost of production in other lines. Yet since the State of Washington has enormous areas fitted only for the growth of timber, or far better for such growth than for any other purpose, it seems exceedingly important that the capital be forthcoming. If capital is not secured, the state will be unable to utilize this area, unproductive for other purposes, and by so much fail to obtain the full productivity that its resources warrant. Failure of this raw material for industry means so much less industry, which is also a very important matter.

Sources of Capital for Forest Production

There are four sources of capital which may in a greater or less degree be relied upon for large scale forest production, viz., the nation, the state, the municipality, and the large corporation. As previously stated, the cost of capital to practically all others is so high that the well informed forester cannot conscientiously recommend forest production as a profitable or even a self supporting enterprise, except in the case of the farm woodlot. Of these four possible sources of capital the municipality may for the present be expected at the most to deal only with city watersheds, although it would be an excellent investment for many cities to secure adjacent tracts of rough lands for forest parks, which could serve, not only for park purposes, but also give revenue to the city. The large corporation cannot be relied upon to furnish the capital now nor at any time in the future until it is definitely decided whether it will have equal privileges with other owners.

It then devolves chiefly upon the state and nation to raise the necessary capital for this need, which a little careful consideration shows to be vital to the state. The State of Washington has done nothing in this line as yet and it will no doubt be difficult for it to devote large sums to this purpose. Instead, therefore, of there being any jealousy of the work of the federal government in forest production, it seems that intelligent cooperation should be the uniform rule. The writer expects to see the day when there will be a vigorous demand from the people through members of Congress for the expenditure of government funds for this purpose to the end that the resources of the state may be made as productive as possible. Certainly such productive expenditure is far more important to the state than federal expenditures on government buildings, which merely result in moving government offices out of private buildings, and by so much decrease the demand for space in the latter. The main advantage of these latter expenditures is the purely selfish one, that because of the supposed prodigality of the government, persons who have something to sell (either material or labor) may sell more of it at better prices for the construction of a government building than for a private building to house the same offices. Forest production by the federal government means not only benefits from present expenditure of government funds in the state where they do not interfere with private enterprise, or even with investment by the state (because there is more to be done than both can do), but also that the productive results of these expenditures will mainly accrue to the state in the future because its citizens will receive wages for protecting, growing, and harvesting the timber, and when mature using it at reasonable cost primarily in wood industries, and ultimately in all the other industries of the state.

The federal government at present, however, has its hands fully occupied in the administration of the considerable areas already set aside for forest production. There is no probability that those areas will at present be extended by purchase of private lands, although a policy of acquisition of alienated lands inside the present boundaries of the National Forests would be very useful. Aside from the National Forests, irresistible logic leads to the conclusion that for the present nothing will be done to continue cutover lands and land unfit for agriculture, as producing areas, thus contributing to the industries and general welfare, unless it be done by the state.

Will a people, granted popular rule, make expenditures, the benefits of which will accrue in the more or less distant future, or will they only make expenditures of the hand-to-mouth sort? Will they use their natural resources with regard only for today, looting and destroying in any way to make today's profit the easiest at whatever expense to the future, or will these resources be conserved? This is undoubtedly the severest test of democracy, if not the supreme test, in the long run. If only today's needs are considered and resources destroyed without measures being taken for replacing the renewable ones, it needs no prophet to see that the power of a given area to support population must continually decrease. Place against this the fact that population normally increases and we cannot escape the conclusion that a continually lower standard of living must follow, together with a lower civilization as its inevitable result.

The United States, with its great resources and small population, has not felt the results of the enormous waste of its resources as yet. Certain eastern states are beginning to feel them in so far as it concerns their forest resources, and are taking steps, halting and inadequate so far, to provide for the future. It remains to be seen whether Washington will act in time or whether it, too, will wait until the damage done is so great as to render the cost of repair many times greater than it would be if immediate action were taken. It seems certain that a wider knowledge of the need and wonderful possibilities before the state will contribute to the desired end.

While it is not within the field of this discussion to make extended suggestions as to state policy, one point deserves mention. Referring to Table V, showing costs of production on the poorest quality soil, it may be noted that with private owners the cost of production runs from $14.01 to $37.50 per M. feet. As the material produced on this poor quality soil will be very small sized at 60 years of age and consequently of low value, it is unsafe for any private owner to expect to undertake production of timber in this soil quality unless in very exceptional cases. The state or federal government may do so with a reasonable expectation of at least paying costs. Since this class of land is most certainly not agricultural in character, it would seem that this would be a wise point of attack in beginning a policy of purchase by the state for the purposes of forest production. Here at least is land which will produce nothing unless the state produces timber upon it. This it can do with benefit to its industries and without damage to any private interest. The extension of the purchase policy could be worked out as the needs of the future might suggest.

Comparative Cost of Providing a Future Supply by Growing New Timber and by Hoarding Old Timber

This subject is introduced here because of the close relationship to the problem of growing timber. Most corporations, and to a large extent the federal government, proceed on the theory that the best way to insure a timber supply in the future is by hoarding mature timber. It is of interest, therefore, to apply the financial test to the cost of holding timber as compared with growing it. This can be done in several ways, one of which is by reducing to present value the stumpage price at which, in the foregoing tables, it has been shown that timber can be produced. In these reductions the same interest rate should be used as was used in computing the cost of growing timber.

Thus by reference to Table III, covering cost of growing timber on Quality II soil, we find that a corporation working under 5% interest can produce timber for $9.87 per M. ft. B. M. on a 60 year rotation. It would then not be profitable to pay an amount for mature timber (not increasing its volume, but to be held 60 years) which would bring its cost to more than $9.87 at the end of that time, except as the timber now mature would be of higher quality. The amount that could be paid per M. would be the present worth of $9.87, less the present value of the cost of protection and taxes throughout the period. It is somewhat difficult to determine the latter costs, but a conservative figure may be ascertained. Since the researches of Prof. F. G. Miller show that timber is already taxed ½c per M. per annum on the average, and the fire risk and protection must also be counted, it seems that 3c per annum throughout the period would be a very low cost for this item. The solution then follows.

Referring to interest tables* we find that the present value of $1.00 due 60 years hence will at 5% compound interest be $.0535. The present value of $9.87 will then be $9.87x$.0535=$.53. Referring to the same table, we find that the present value of $1.00 due each year for 60 years is $18.929. The present value of $.03 due each year for 60 years would be $.03x18.929=$.57=present value of the administrative costs, taxes and other expenses of holding the timber. Deducting the $.57 (the cost of holding) from $.53 (the present value of $9.87, the cost of producing timber) we have —$.04, that is, even if the timber were given to a corporation to be held 60 years it would be cheaper to grow it than to take the old timber.

To consider the holding of timber in private ownership for 60 years would be far fetched except perhaps in the case of the largest corporations, which could be placed on a basis of permanent investment. It would, however, easily be possible in many cases for corporations or companies wishing to insure a future timber supply to their mills to secure tracts bearing young growth at prices which would give the same advantage relative to the short length of time held that the above example gives for 60 years. For example, Douglas fir stands 10 to 50 years old can often be purchased at prices little greater than the land value. If the land value in such cases does not exceed \$10.00 per acre and the timber can be bought for \$10.00 per acre, the cost per M. of the stumpage at the end of 20 years would be as follows, where the interest rate is 6%. Interest on land value 20 years$=\$10.00x(1.06^{20}-1)=10.00x2.21=\$22.10$. Cost of young timber is $10x\$3.21=\$32.10$. Cost of protection and administration for 20 years equals $\frac{20(1.06_{20}-1)}{.06}=\$7.36$

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*C. S. Schenck "Forest Finance," p. 39.

Total cost per acre of the stand at end of 20 years equals $\$22.10+\$32.10+\$7.36=\$61.56$, total cost per acre. If the acre is well stocked and on Quality I forest soil it should yield 44,000 ft. B. M. per acre at the age of 60 years, thus the cost per M. ft. 20 years hence would be \$1.40. That is, it would have to sell for only \$1.40 per M. ft. to give the present purchaser on those terms 6% on his investment. Mature timber, no longer making growth, purchased now for even as low as \$1.00 per M. and held for 20 years on land worth \$10.00 per acre will cost as follows where the stand is 50,000 feet per acre and the annual expense of protection is 20c per acre. Cost of original stumpage payment per acre equals

$$\$50.00x1.06^{20}=\$50.00x3.21=\$160.50$$

Use of land$=\$10x(1.06^{20}-1)=\$10x2.21=\$22.10$

Annual cost of administration and protection

$$=\frac{20(1.06^{20}-1)}{.06}=\$7.36$$

Taxes at 2c per M. per annum$=\frac{1.00(1.06^{20}-1)}{.06}=\$36.78$.

Total cost per acre at end of 20 years

$$=\$160.50+\$22.10+\$7.36+\$36.78=\$226.74.$$

Cost per M$=\frac{226.74}{50}=\$4.57$.

Of course this old timber will be more valuable material but not sufficiently so to make this as good an investment as the young timber even at the low price of \$1.00 for the old. Where \$2.00 is paid now the stumpage price must be over \$9.00 per M. in 20 years to make the purchase a 6 per cent investment. Of course, every individual case of this sort must be dealt with on its merits.

The comparative cost of insuring a future timber supply by growing timber or by storing mature stands is a more important question on state and federal lands than on private lands, because it is a reasonable conclusion from the tables of cost of growing timber that upon the state and nation will devolve this task. The state is already pursuing an active policy of sale of mature timber, but many people question the federal policy, which is providing for very few sales. There are on the National Forests large areas of mature and over-mature timber which could be sold for \$1.00 per M. feet or more in any normal times. These stands are over-mature and tend rather to decrease than increase in volume. They average 40,000 to 50,000 feet B. M. per acre. The cost of holding a stand of this nature of 40,000 feet volume on Quality I soil would be as follows, figuring 3 per cent interest, a present value of $1.00 per M., $10.00 per acre for soil value and 20c per acre for protection and administration.

$$\text{Soil rent}=10.00\text{x}1.03^{60}—1)=\$10.00\text{x}4.892=\$48.92.$$

Future value of timber at compound interest for 60 years

$$=\$40.00\text{x}1.03^{60}=40\text{x}5.892=\$235.68.$$

Protection and administration cost 20c per acre for 60 years

$$=\frac{.20(1.03^{60}—1)=\$32.61}{.03}$$

$$\text{Total cost of holding per M.}=\$317.21\div40=\$7.93\text{ per M.}$$

Comparing this cost with $3.36, the cost of producing timber on the liberal estimates shown in Tabel IV it will be more than twice as expensive for the federal government to secure future timber supply by holding mature timber now worth $1.00 or more per M. than it would be to cut off such timber and reforest so as to raise a new crop during the 60 years. It is, of course, freely admitted that the value of the old timber per M. feet would be greater than that of the young, but in no such proportion as indicated above. The cutting of old forests and the growth of the young on the ground thus vacated will also result in the area furnishing within the 60 years over twice as much volume of timber for use of the people. Seemingly this should be the chief consideration.

It is argued, of course, that the government does not intend to hold the old timber so long, and that by cutting in 20 to 30 years the government can make great profits by holding. This is too great a question to treat in detail here, but there seems to be no difficulty in demonstrating that this is poor financial policy. However, it is not necessary to resort to financial arguments to show that the policy of holding mature and over-mature timber is bad from the public standpoint, because in a great measure it defeats one of the principal objects of the National Forests, viz., to furnish a large volume of timber for use by consumers. This is defeated because the soil functions only for the storage of old timber, not for the growth of new. Proper forest management requires, however, that the old stand be removed gradually and replaced by new. Where the federal government does cut timber, effort is made to see that the ground is reforested.

With the state, the argument for immediate cutting of mature timber within reasonable limits is still stronger, because the interest rate is somewhat higher. The cost of holding mature timber, involving a large initial investment as compared with growing new timber is, therefore, still higher. The state's policy fails when it comes to growing the new timber, however. Nothing is as yet being done in this direction, so that land when cut over is not even functioning for storage of timber. The two policies may thus be contrasted, the state's being inadequate in the direction of growing timber after cutting, and the federal government in the direction of a reasonable amount of cutting so as to permit growth of new timber.

Summary of Principal Conclusions

1. The chief cost of producing timber is the interest on the capital involved.
2. It follows from (1) that the interest rate under which the forest owner works, to a large extent determines the cost of producing timber to the owner concerned.
3. Taxes, though important, are a minor cost as compared with interest charges.
4. The costs of production under high interest rates are so great as to bar forest production to those owners who cannot secure money at a rate not much, if any, higher than 5 per cent.
5. This makes forest production at a profit possible only to the federal government, the state, the municipality and the large corporation, and those owners exceptionally situated as to the ownership of land for other purposes, such as mining, in connection with farming, etc.
6. Since the federal government is already practicing forestry so far as its resources make practical at present, the large corporation is not likely to become interested under present conditions, and the municipality can engage only to a limited extent; there is little hope of introducing forest practice in adequate manner except through the state.

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PAPERS AND DISCUSSIONS

Reforestation of the Cedar River Watershed.

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AND
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DESCRIPTION OF WATERSHED.

The term "watershed," in its strict signification, means the edge of a river basin; the line, or "divide" separating the water flowing into two different rivers or river basins. The watershed, as thus defined, limits, or forms the boundary of, its catchment area, as used in hydraulic engineering.

As applied to the watershed of Cedar River, local custom, and the terms of the ordinances and enactments of the City of Seattle, have given to the words "Cedar River Watershed" a wider significance. These words, in this sense and as uniformly used in this report, mean the entire area of land drained by Cedar River and all its tributaries, from the summit of the Cascade Mountains down to the intake of the pipe lines which convey to the City of Seattle the water from Cedar River to the watermains and reservoirs in the city.

This intake is located at a point about twenty-three miles in an air line southeasterly from Pioneer Place, at what is known as Landsburg. From the lowest point of the watershed at Landsburg, at an elevation of 540 feet above city datum, to the highest point, in the vicinity of Yakima Pass at the summit of the Cascade Mountains, at an elevation of about 5300 feet above city datum, the length of the watershed, measured in an air line, is about twenty-five miles, and its area is 137 square miles. Following the sinuousities of the river, this distance is thirty-one miles, in which distance the waters of the river fall 4760 feet. Of this fall, the greater part occurs in the first few miles of the river's course, where the streams are torrential in character, in many places plunging over cliffs of considerable height. As the distance from the summit of the mountains increases, however, the fall becomes less rapid and at a point about fourteen miles from the summit of the mountains the current of the river is checked by the waters of Cedar Lake.

Cedar Lake has a length of about three and one-half miles, an average width of about one-half mile, and is of great depth. The surface of the lake originally was at an average elevation of about 1530 feet above sea level. The construction of the timber crib dam near the outlet of the lake, in 1903-4, has resulted in the raising of the water about seventeen feet.

Leaving the dam at the outlet of Cedar Lake, the river flows through a deep and narrow canyon, having a very precipitous descent of 600 feet in a distance of three and one-half miles. At the foot of this descent is located the Municipal light and power plant of the City of Seattle.

After leaving the power plant, at an elevation of 920 feet above sea level, Cedar River flows through a fairly level valley for a distance of about twelve miles to Landsburg, at an elevation of about 540 feet above sea level.

The watershed is divided naturally into two main divisions, referred to in this report as the upper watershed and the lower watershed. The upper watershed extends from the site of the proposed masonry dam, at a point on Cedar River about two miles below the outlet of Cedar Lake up to the summit of the Cascade Mountains, covering an area of about eighty-three square miles; and the lower watershed extends from the site of the proposed masonry dam down to Landsburg, covering an area of about fifty-four square miles.

It will be noticed that the upper watershed is practically the watershed of Cedar Lake, which constitutes the lowest point of this upper watershed. It is characterized by steep and precipitous mountain slopes rising abruptly from the shores of Cedar Lake and from the narrow valley of Cedar River, and of Rex River, to the summits of the flanking ridges on each side. In many places there are found extensive areas covered by masses of rock, either in the form of cliffs or what are known as rock slides. Near the summit of some of the mountains there are open parks and grassy meadows, in which but little timber is found; but, aside from the barren spots, the entire area is covered by a heavy growth of timber. This timber varies in character from stands of Douglas Fir in the valleys, where a single tree often reaches a height of 250 feet, with a diameter of six feet at the base, to the scattering and scrubby growth of what is known as upper-slope type of timber, upon the summits of the mountains. It is estimated that the present stand of commercially valuable timber upon this upper watershed exceeds in amount one billion feet, board measure.

The lower watershed, although bounded upon the north, east and southeast by mountain ridges, is what may be characterized as rolling or bench land. The timber which originally covered the lands in this lower watershed was, generally speaking, of a larger growth and more valuable than that upon the upper watershed, by reason of the fact that the lower elevation is more favorable to timber growth and affords a longer growing season.

By reason of its proximity to the railroads which were first built into this country, and of its general accessibility, logging operations in this lower watershed were begun at an early period and a considerable portion of this area has now been denuded of timber and is ready for reforestation.

Policy of the City of Seattle in the Acquisition of Lands in the Watershed

The acquisition of lands in the Cedar River watershed by the City of Seattle, in connection with the construction of the Cedar River water supply system and the municipal light and power plant, and for the purpose of protecting the water supply from pollution, was undertaken by the city about thirteen years ago, beginning in a small way and extending from year to year as time went on, until there is now owned by the City of Seattle, within the watershed, a total area of 37,982 acres, or 59.39 square miles.

The policy of the city in acquiring the lands within the watershed for the purpose of protecting its water supply is one the wisdom of which has been demonstrated by the results obtained up to this time, and the continuation of this policy in the acquisition of the remainder of the land in the watershed will result in giving the City of Seattle an assurance of a continuation of an adequate supply of pure and wholesome water not surpassed by that of any city in the world.

At the time the acquisition of these lands was first undertaken by the city there were located within the lower watershed several saw mills and logging companies which had been operating there for a number of years. The city at that time had not sufficient money to undertake the purchase of the timber belonging to these mills and logging companies, or of the mills and equipment of the companies; and for that reason, the operations of logging and cutting of timber have been carried on in this lower watershed by private parties up to the present time and are still being carried on in such manner. The city has been successful, however, in the regulation of these operations so that the danger to the water supply has been reduced to a minimum and the operation of the camps and of the mills has been carried on in a reasonably sanitary manner.

Within the upper watershed, however, extending from the site of the masonry dam at Camp 2, including Cedar Lake and reaching to the summit of the Cascade Mountains, no logging operations had been commenced at the time of the establishment of the city's policy to acquire the land in the Cedar River watershed, and up to this time the City of Seattle has been successful in preventing the establishment of logging camps and saw mills in this territory. In order to prevent the establishment of these camps it has been necessary for the city to purchase, in many instances, not only the land, but also the timber standing thereon. In this manner there has been acquired timber having an estimated value at the present time of nearly $700,000.00. The total cost of the acquiring of all the land and timber in the watershed up to this time, exclusive of cost of surveys, appraisals and court costs, is something over $600,000.00, or nearly $100,000.00 less than the estimated cost of the timber alone. Adding the cost of survey, appraisals, timber cruising and court costs, it is found that the value of the timber belonging to the city is approximately equal to the cost of acquiring both land and timber up to the present time.

If the established policy of the city, as approved by the voters in authorizing the issuance of bonds in the amount of $1,000,000.00 for the purpose of acquiring the land in the watershed, be continued by the city in the future in the acquisition of the remaining land and timber in the upper watershed, it should result finally in the obtaining of the entire watershed without material cost to the city. In other words, the increase in stumpage value of timber should be sufficient to pay for the cost of acquiring the land. In order to realize these values, however, it will be necessary, under proper sanitary regulations, to cut and market the timber. Upon the removal of this timber there arises the problem of determining the best use to be made of the logged-off lands.

Necessity for Adoption of a Fixed Policy and Definite Plan for Management of Lands in the Watershed

The operations of the logging companies in the lower watershed have already resulted in the denuding of large areas of land once covered with a heavy growth of valuable timber. The greater part of this logged-off land is now the property of the city. It was acquired for the purpose of protecting the water supply of the city from pollution, and in order to carry out that purpose the acquisition of the lands was amply justified. In its present state it does not constitute anything of value to the city except for the particular use and purpose of protecting the purity of the water supply. It may have a potential money value, however, dependent upon the use which can be made of it.

If left to itself this logged-off land will be covered by a growth of weeds and a scattering growth of inferior timber and will remain non-productive and of practically no value to the community and to the state. It is evident that a policy of this kind, if applied to the watersheds which constitute the sources of supply of all of the large cities of the state, would result in the withdrawal of enormous areas of land from productive use, would cause a great economic loss, and would prevent the proper upbuilding and development of the state.

The problem is to determine the best use to be made of these logged-off lands within the watershed, having due regard to the necessity of protecting the water supply.

It is evident that the use of these lands for agricultural or dairy purposes, if they were adapted to that use, would be one which would not be consistent with the purpose for which they were acquired, for the reason that it would mean the occupation of the land by large numbers of animals and the introduction of a resident population with consequent danger of pollution of the water supply.

In the same way, the development of any manufacturing or industrial enterprise upon these lands would be a menace to the purity of the water supply.

The use of these lands, however, for the growing of timber does not require the continued residence of any large number of men, nor the establishment of a resident population with its attendant dangers, and would result in a great benefit to the quality of the water supply of the city, as well as in conserving that water supply and, to some extent, in regulating the run off of the streams. If a growth of valuable timber upon these lands can be secured at a low cost within a reasonable time and under conditions which would warrant the incurring of the necessary expense from an investment standpoint, with a reasonable likelihood of a profitable return to the city, it would seem to justify the undertaking. At least, investigations and experiments for the purpose of determining the advisability of adopting a plan for the ultimate reforestation of all of the lands within the watershed should be made and a fixed policy should be adopted by the city for the handling of the lands in the watershed.

The production of a growth of valuable timber on this land would result in the creation of an asset of enormous value to the community at large in the place of a doubtful asset, or possibly a liability, if no systematic or organized effort is made for the reforestation of these lands and the area is allowed to grow up to weeds and a scattering growth of inferior timber having but little value. In other words, the adoption and carrying out of a fixed policy and a definite plan will create values where otherwise they would not exist.

In order to determine the feasibility and advisability of adopting such a plan for the reforestation of this area, a careful study of the watershed with a view to its use for this particular purpose has been carried on for a period of four years. During this time an exhaustive examination of the entire area of the lower watershed has been made for the purpose of obtaining the data used in the preparation of this report, covering all of the features of the reforestation of the lower watershed.

No report is made as to the reforestation of the upper watershed at this time, for the reason that this would await the advance of logging operations into this area and should receive more study than has yet been given to it.

REFORESTATION OF LOWER WATERSHED

SECTION I.

General Description.

The lands dealt with in this plan all lie west of the divide, between the streams flowing into the area above the new masonry dam and those flowing into Cedar River below it. That is, this area is that described in the introduction as the lower watershed, and it comprises a total area of 36,322 acres, or 56.8 square miles. This area is somewhat larger than the actual drainage basin, as it was necessary to obtain the entire area of every "forty" through which the crest line passed.

In this area the lands already logged-off (at the end of the year 1912), comprised 15,752 acres. About 780 acres, however, are railroad rights-of-way, and other such-like areas, which leaves a total area of 14,972 acres or 23.4 square miles of lands at present in need of reforestation. A most vitally important point, as can be noticed on the map, is that these logged-off lands are not in small scattered patches, with timber around them, but they lie in large, solid blocks, covering many square miles, with no timber near at hand. This eliminates the chance of the area seeding up from the adjacent forest, and as no live trees are left on the greater part of this area and as the fires that have swept over here for the past eight or ten years have entirely destroyed any seed that might have remained in the soil, the only method by which a new forest growth can be obtained is by some artificial means. The best proof that such means must be used is shown by the fact that, on actual counts made on some areas in Taylor Creek, and also near Barneston, on areas covering from one-quarter to one-half a square mile, not one single young tree nor seedling of Douglas fir nor any other commercial species was found, and that, after having had from eight to ten years, since being logged, in which to show evidences of a new forest coming up.

The remaining 20,670 acres, or 32.2 square miles, is at present still timbered, but the two logging companies now operating are denuding this at the rate of about 800 acres every year. It is estimated that on about seven square miles of this area the timber is too poor to be cut, so that, eliminating this, it means that in from 15 to 20 years there will be about 16,200 acres, or 25.3 square miles, more of logged-off lands, which, present conditions being allowed to continue, will also become a barren waste. This brings the total area up to 31,200 acres, or 48.75 square miles, on which there is a present or will be a future need for a plan of reforestation.

NATURAL DIVISIONS.—The entire area falls naturally into four main divisions according to the four drainage basins in which it lies. These divisions are as follows:

DIVISION No. 1.—The Rock Creek, Webster Creek, and Walsh Lake drainage basin.

DIVISION No. 2.—The drainage basin of William's Creek and Cedar River above Taylor Creek.

DIVISION No. 3.—The Taylor Creek drainage basin.

DIVISION No. 4.—The narrow strip of land draining into Cedar River from both sides, and lying below Taylor Creek. The location of these four divisions is shown on the map.

It is of great advantage to divide the area in this manner, as the entire tract is too large and presents too many and varied conditions to admit of specific handling as a unit. It is not necessary here to give detailed descriptions of each division, and it is sufficient to state that, for the present, DIVISIONS Nos. 1 and 2 are the most important to consider as they have the best site and soil qualities and the best economic situations, which means that they will yield the best and quickest returns. Also they can be more advantageously worked and are more in need of it than is the rest of the area.

A close and detailed study of the entire area was made for data along the lines of such natural factors as govern or influence the work and a brief description of such factors follows:

TOPOGRAPHY.—The elevation varies from 540 feet above sea level, at Landsburg, to as high as 4000 feet at the headwaters of Taylor Creek. However, nearly 90% of the present logged-off lands lie below the 1200 feet contour, while where future logging will be done, but little will be above the 2200-feet contour. In fact, on the whole 31,200 acres as planned for, over 66% lies below the 1600-foot level, and practically all of it below the 2200-foot level. As elevation is one of the main factors governing both the rapidity and quality of tree growth, this natural condition is here a most advantageous feature.

Exposure, too, is of great importance. Here, the greater part of the land is so gently sloping, or else level, that it cannot be said to have any definite exposure, but receives sunlight all the day. As for the steep hillsides, about 75% of such land has a south or southwestern exposure, which is, of course, the best, and so it may be said that, from this point, the entire area is favorably situated.

The land itself may be classed as bottom land, bench land, gently rolling and mountainous. The amount of bottom land is, however, practically negligible, while that which is classed as mountainous, or exceeding 20% in slope, is less than 15% of the area. And the work should be done on the latter class as much for protection against erosion as for the financial returns. There are several large areas of well-drained bench land, but by far the greater part of the whole area may be classed as rolling or gently sloping. And it is these last two classes of land, with their deep, porous soils, that yield the very best growth of fir, as was evidenced by the former growth.

CLIMATE.—As most of the species used in this work would be natives of this region, it is self-evident that they can live in this climate and the main study was to see just how advantageous the climatic factors would be. Rainfall is, of course, the most important. Readings for the past ten years give an average annual fall at Landsburg of 52 inches while at Cedar Lake it reached an average of 112 inches. This is more than ample for the best growth.

The relative humidity is very great, which favors a rapid growth. Extremes of temperature are not great, as it rarely goes as low as zero, nor much above 100° F., and such extremes are not at all detrimental. The length of the growing season is very long, beginning early in April and lasting well up into October. This gives a season of about seven months, which, combined with the other favorable factors, insures a large annual growth.

The natural climatic factors which might be considered harmful, such as wind, frost, drought and heavy snow, are nowhere severe enough to afford any real menace.

SOIL CONDITIONS.—The soils found here are loam, clay, sand and gravel, and rock, or rather, varying admixtures of these constituents, and in some places there is some swamp land. Where the soil is rich and loamy it will be best to plant eastern hardwoods, both because of the chemical composition of the soil and of its moisture-holding qualities. On the swampy areas the soil, while very moist, is not acid, and there spruce and cedar may be used or possibly ash or cottonwood. But by far the greater part of the area is sandy soil, with varying admixtures of gravel and rock. This soil is porous and well drained, good qualities for the growth of fir; deep, so that the trees will have a good root development, and, while rich enough in all the mineral elements required by Douglas fir, is still not rich enough to support a rank weed growth that would kill out the young trees.

GROUND COVER.—Under this heading, two classes may be considered; first, the weed growth that has come up; second, the debris, down logs and snags left after lumbering. Needless to say, this applies only to the lands already logged-off, as ground cover is of no importance on the lands still timbered. The larger part of the area is covered with a light growth of salal and ferns, which is not heavy enough to hinder the growth of young trees when set out, but which might make it impossible to sow seed directly. Parts of the area, especially near Barneston, are practically free from weed growth and there seed sowing may be done. On the other hand, some portions, particularly up Taylor Creek, have such a dense growth of salmonberry, fire-weed and ferns that they present a serious problem, and it will probably be best to burn them over before working on them.

The other class of ground cover, as down logs, debris and old snags, are important only in so far as they make the work of the men harder, thereby increasing the cost, and also as they increase the fire risk. Such debris occurs, in greater or less density, over the entire area, but is thick enough to cause serious trouble only in some parts of Taylor Creek valley. On some portions there are also thick stands of young pole-woods, which have been killed, and these will have to be cut down and burned, which will be rather expensive, but they are of rare occurrence.

SITE QUALITIES.—By site quality is meant the capacity or ability of the site to produce tree growth. Three site qualities are recognized in this country, and the difference of these qualities is determined by the occurrence and combination of all natural factors, such as soil, elevation, exposure, climate, etc., which have previously been discussed. Also the quality of a site depends upon the species which is to be grown upon it, as for example, a deep, light, porous, sandy, well-drained soil, which, at low elevation, would constitute a No. 1 quality for Douglas fir, would only be a No. 3 quality for spruce or some of the eastern hardwoods. However, the areas best fitted for hardwoods, and also spruce and cedar, were first determined and the following study and discussion of site qualities refers only to sites intended for the growth of Douglas fir and such species as may be associated with it, as white pine and a few others, and this includes practically 90% of the entire area. The importance of knowing the areas of these different site qualities can be seen, when it has been calculated that, at 100 years, a No. 1 quality site will produce 100,000 feet B. M. per acre, a No. 2 quality site only 66,000 feet B. M. and a No. 3 quality site only 49,000 feet B. M. per acre. This is of the utmost importance when it comes to forecasting future results.

Site qualities were first determined on timbered areas, mainly by a study of the heights of average trees, for it is a law that, in even-aged stands the height of an average tree varies directly as the quality of the site; that is, the taller the tree, the better the site qualiy. At the same time the diameter of trees were measured and all natural factors, with their influences, were noted. Similarly situated areas were then found on the logged-off lands and the diameters of the stumps were measured as a check. Comparison of the surrounding lands was then made and the effect of differences in soil conditions, exposure, elevation, etc., were noted and the proportion in which they affected the quality. In this way, and from a knowledge of how different combinations of conditions affect tree growth, the different site qualities were determined.

These qualities were then checked again by a comparison with the general site qualities for Douglas fir in western Washington and Oregon as determined by the U. S. Forest Service. This general classification is as follows: No. 1 quality occurs below 1000-foot elevation; soil loamy, mixed with sand, clay or gravel, deep and well drained; land generally bench land or gently sloping. This site occurs mainly in the valleys of larger rivers and would generally be called agricultural land. No. 2 quality occurs generally from 800 to 1300 feet, though sometimes as high as 2000 feet. Soil is generally of a sandy or gravelly nature, from shallow to medium depth, and land is gently sloping or even steep. This site occurs mainly in the foothill regions. No. 3 quality occurs above the 1500-foot elevation. Soil is shallow, gravelly sand, with rocky subsoil and many rock outcrops. This site generally occurs at higher altitudes and with rough topography.

Of course, in classifying the different site qualities there were many cases where one would merge into another and it would be hard to tell to which quality it did belong. In such cases it was the invariable rule to put all lands in doubt into the next lower quality so that any error that might occur would be one of safety, and that would insure conservatism in the figures.

SECTION II.

Methods of Originating New Forest.

In considering this subject it is first necessary to distinguish between the two main classes of land, namely: those now logged-off and barren where the new forest must, of necessity, be started by some artificial means, and those lands which are still timbered, but which will be logged in the future, where the methods used may be either artificial or natural or a combination of both.

ON LANDS ALREADY LOGGED-OFF.—On these lands there are two entirely separate methods of starting the forest. First, by a direct sowing of seed; second, by the setting out of young trees. First, the direct sowing of seed will be discussed.

DIRECT SOWING OF SEED.—As this work will not be done extensively enough to warrant building a conery, the seed will be bought in the open market, at a price varying from $1.75 to $2.25 per pound. Good, clean Douglas fir seed contains about 43,000 seeds per pound, with a germinating percentage of about 55%, according to tests made, so that an estimate of 20,000 vital seeds per pound is conservative. Three methods of direct sowing of seed can be used, the seed-spot method, the strip method, and broadcast sowing. However, under the conditions existing here, only the seed-spot method is applicable, and the following description and cost data applies only to it.

In this work, three men form a crew, two preparing the spots and one sowing seed. The spot is scraped bare, from 12 to 20 inches square and 20 to 30 seed are dropped in, a little earth kicked over them and lightly pressed down. The spots should be spaced about 6 feet by 6 feet, making 1210 spots per acre. Closer spacing would be too expensive and further spacing would hardly yield good enough results. One crew of three men should prepare and sow from 3000 to 4200 spots, or from 2½ to 3½ acres per day, with a spacing of 6 feet by 6 feet, the area covered varying accordingly as the amount of down timber and debris hinders the men.

The main points of advantage of this method are the following: The cost of the seed is small and the work can be done rapidly, making the whole operation a cheap one. The preparation of the spot insures the seed coming into contact with the mineral soil, a necessary requirement for its germination. Some choice is given in preparing the spots in the most favorable locations. The results can be watched and points obtained for future guidance. Above all, there is the big advantage that always occurs when a forest comes up with a certain degree of regularity in the spacing of the trees, instead of in a haphazard form. All of these points indicate that the method may be used on some parts of the area.

The best season for this seed-sowing work is in the fall, as then the seeds get plenty of moisture and in spring the young seedlings have attained a good start before having to face the summer, whereas if the sowing were done in the spring an early hot dry spell might kill everything. The ravages of birds and rodents may do a great deal of damage and must be guarded against. As a protection against birds the seeds may be coated with red lead, while poisoned grain, scattered or placed over the area, is the best protection against the rodents. The cost of this is very little.

The following are general costs for seed-spot work: Spots spaced 6 feet by 6 feet or 1,210 spots per acre. Seed used, an average of 25 per spot or 0.7 pounds per acre, costing $1.40. Administration $.50 per acre.

Three men, at $2.75 per day, to plant from 2½ to 3½ acres per day, according to the roughness of the ground. Total costs will then run from $4.25 per acre to $5.20 per acre. If properly done, on areas favorable for the work, the results should be somewhat better than one seedling per spot on the average. The broadcast and strip methods require so much seed and preparation as to render the cost too excessive for the results secured, and will not be used here.

OUTPLANTING OF NURSERY STOCK.—However, by far the greater part of the area must be stocked by the setting out of young trees. The only reasons in favor of seed sowing are speed, and so covering a large area in a season, and the slightly cheaper cost. Against this must be set the risk that the work may not prove successful and also the inability of the method to insure certain silvicultural advantages that can be obtained by setting out young trees. Some of these advantages are as follows, and all are important: The young stock, two years old when set out, has its root system well developed and can take hold in the soil at once, thus insuring growth. Correct and regular spacing is obtained, which means a full utilization of the productive power of the soil, a forcing of the height growth, and the formation of a clean bole, and the securing of the maximum yield for each site quality. An absolute even age of the new forest is secured, thin spots are obviated, and the young trees can be easily located and their development watched and tended. Future treatment of the stand is made easier and the forecasting of future results and returns can be done with a greater degree of certainty. And especially where it will be deemed best, as will often be the case, to have an admixture of two or three species on the same area, some perhaps several years older than others, the nursery stock offers the only method of securing such a forest. And, added to all these advantages are the facts, first, that on about 70% of the area, or 11,000 acres, it will be absolutely necessary to set out young trees, as the heavy weed growth precludes any chance of seed sowing, and second, that seed sowing cannot be used for some of the species desired, but the young trees themselves must be set out .

So, seeing that most of the work would be done by setting out nursery stock, a plan was drawn for the location of a nursery at Cedar Falls. The city already owns a piece of land there, admirably adapted to the purpose, with good soil, level, and well drained, southwestern exposure, and centrally located for transportation purposes to the entire area and also to the upper watershed. The plan was drawn for a nursery capable of raising 250,000 trees annually, and it admits of being enlarged to a capacity of half a million trees if desired. The stock to be grown, of Douglas fir, will probably be what is known as 1-1 stock; that is, one year in the seed bed and one year in the transplant bed. Other species will, of course, be grown so as to give the best results for them. It is estimated that such stock can be raised at a cost of not to exceed $4.00 per thousand trees.

The work of outplanting may be done in either the fall or spring, but preferably in the fall, for the following advantageous reasons: The loose earth around the plants is packed in firmly during the winter, and the trees set in more firmly; if the root systems are injured during the outplanting they have a chance to heal during winter; if the species are early budding ones, or if there should be an early spring, the plants are already to take advantage of it; labor is cheaper and easier to obtain in the fall, and, above all, plenty of moisture is assured at the time it is most needed.

In the work of outplanting, the plants are transported from the nursery to the field operations, either by wagon or packed in boxes on pack horses. They are then "heeled in;" that is, put under shade or protection and the roots covered over with moist earth and straw, and are distributed to the men as the work progresses. Each man carries with him half a day's supply of plants, renewing it at noon and on the average it may be figured that 400 plants a day should be set out for each man in the crew; an estimate which makes full allowance for bad weather, for in good weather the average should be fully 500 plants per man per day.

The most important point in the outplanting is the determination of the correct distance for spacing the trees, and several important factors govern this. From a silvicultural standpoint close spacing is desirable, as then a rapid height growth is forced pruning of the dead limbs occurs earlier and consequently a greater clear length of the bole is obtained and more and better quality of the product is the result. Also, the closer the spacing, the earlier a complete crown cover is obtained, with the consequent protection of the soil. Against this must be balanced the financial aspect of the subject. The closer the spacing, the greater the initial investment, both for the stock set out and for the cost of labor, and this initial investment must bear interest for a period of 70 to 90 years. As every dollar invested and figured at 4½% compound interest—the rate at which the city figures its investments—will amount in that time to from $21.78 to $52.54, it will be seen that close calculations must be made as to how large the initial investment can be and still leave a profit. And still another angle of view is the fact that here thinnings can be made after 40 years and their returns must be calculated to determine whether or not to space close, at a greater cost, and obtain the revenue from the thinnings, or not to take the chance. It is the author's opinion that there is a splendid future market in this region for these thinnings, as is discussed later under "Economic Conditions," and that consequently close spacing is advisable. This means generally a spacing of 7 feet by 7 feet or 6 feet by 8 feet, making approximately 900 plants per acre and a good part of the area can be planted as close as 6 feet by 6 feet or 1210 plants per acre, while in some parts it may be best to space as far apart as 8 feet by 8 feet, or 680 plants per acre.

In computing the costs for this work, the estimates were purposely made high so as to be conservative, and were based on the following terms: Cost of growing in nursery, $4.00 per thousand. Transportation to field, $1.00 per thousand, very high. Administration costs, $.50 per acre. Labor, $2.75 per man per day, and allowing an average of 400 plants per man per day, on this basis the following table gives the cost of such work:

Table of Unit Cost per Acre for Outplanting 1—1 Nursery Stock.

Spacing distance in field	No. of plants per A.	Cost of plants at nursery	Cost of hauling to field	Labor Cost of setting out	Administration cost	Total cost per acre
6′ x 6′	1,210	$4.84	$1.21	$8.32	$0.50	$14.87
7′ x 7′	890	3.56	.89	6.13	.50	11.08
8′ x 8′	680	2.72	.68	4.67	.50	8.57

ON LANDS STILL TIMBERED BUT TO BE LOGGED.—These lands, however, present an entirely different problem from those already logged-off. Here there is the choice between cutting the area clean and then reforesting by one of the two artificial methods already described, or to use the natural method of leaving seed trees while logging. From a silvicultural standpoint, clear cutting and artificial reforestation may be somewhat better, but economic conditions favor the leaving of seed trees. The great amount of land now barren which must be artificially restocked will require the concentration of such work for several years, which means that if the 800 acres now being annually logged should be cut clean, they would have to lie unproductive until the present barren areas are reforested, after which they can be worked upon. By leaving seed trees, however, the reforesting of this land can be immediately started, and with the other work going on on the other areas at the same time the entire area can soon be brought to a state of production. Another point is the fact that these timbered areas are mostly upon the poorer site qualities, so that with their lower yield and lower expectation value, it is desirable to keep the initial investment as low as possible.

A Douglas fir tree can scatter its seed to a distance of about twice its height. A tree 150 feet high can therefore seed up approximately 1.6 acres, which would require the leaving of about 25 seed trees on a "forty." Such a tree, 150 feet high and 38 inches in diameter, would contain on the average 2000 feet B. M., which at $2.50 per M., makes the cost per acre $3.13. However, it is generally possible to select trees fit for this purpose of seeding, which, because of defect, such as conk, crook, rot, fork, etc., contain only poor lumber and should be charged for at a much lower stumpage rate.

The administrative cost of selecting such trees would be about $.10 per acre. Some care must be used in logging to protect these trees and the additional cost to the logging operation is figured at $1.50 per acre. Also, when the slash is burned, care must be taken to protect these trees, and the cost of this is figured at $.75 per acre. This gives a total cost for the seed tree method of $5.48 per acre, which is a maximum.

The method is therefore cheap, takes no time for labor outside of the regular operations of logging and has the big advantage that if fire should kill the first growth, the source of seed supply is still present and a new growth can be obtained at no extra cost. Danger from windfall in this particular locality is very small, and if proper care is used in burning the slash, the fire menace to the seed trees is also small. With these points, in addition to the need for speed in the work for reforesting, it is advised that this method be used wherever possible on the lands that are to be logged in the future.

It is probable that under this method bare spaces may occur, where no seed had fallen, or larger spaces may occur, due to the windfall of the seed trees. However, such spaces could generally be planted up by broadcast sowing of seed, or if necessary, by the outplanting of nursery stock, and this objection is not sufficient to overrule the advantages of the method in this particular case.

SECTION III.

Species to Be Used.

The choice of the different species to be used in this work depends upon two points, which may be called the natural and artificial suitability of the species. By natural suitability is meant the degree of adaptation of the tree to the climatic and soil conditions under which it must grow. It must be able to live on the minimum amount of rainfall, grow and lignify in the growing season, stand the changes of temperature, be adapted to the soil and also be able to withstand the winters and frost and be able to protect itself against the diseases of this region. These general conditions were described in Section 1.

By artificial suitability is meant the economic and silvicultural characteristics of the species. The species must be capable of growing fast enough to yield a merchantable product by the end of the rotation, in this case about 70 years, and this product must be of good quality, sound and in every way acceptable to the trade and able to command a good price. Also the species must be such that the products removed as thinnings in the earlier periods should also fill the above requirements. In addition, the trees must be able to adapt themselves to the desired silvicultural method of handling ;that is, to be first started by the method desired and then to be cut and again started as desired. Also they must be such as to be able to be put into such mixtures of species as may be desired.

Of course, all the species now growing here are naturally suited, but not necessarily so from a commercial standpoint. A careful study of all of these has been made and the use of the following species is recommended:

DOUGLAS FIR (Pseudotsuga taxifolia).—This species will be used more than all others combined. The natural conditions are admirably suited to it and it should make a very fast growth, yielding a large amount of saw timber by the end of the rotation. It is the most useful tree of the Northwest, its lumber being in demand for practically all uses, and finding a ready market. It is especially valuable for this work since it can yield in the form of early thinnings large quantities of mining timbers, piling, poles, railroad ties, etc. Silviculturally it is also well adapted for the work, as it can be started easily, and will grow well either in pure stands or in mixture with other species.

Of the other native conifers SITKA SPRUCE (Picea sitchensis) and WESTERN RED CEDAR (Thuja Plicata) will prove useful on the swampy areas. The spruce is a fast grower, a prolific seeder for future reproduction, and does well in pure stands. The wood is valuable for cooperage, finishing, doors and pulp wood and the yield should be fairly large by the end of the rotation. Cedar will do well and its products are valuable, the only drawback being that the rate of growth is rather slow. However, it will be best to use it, at least on some of the swamps. WESTERN WHITE PINE (Pinus monticola). This native white pine grows well in mixture with fir, and has the same soil requirements. The wood is valuable and, though the tree is of slower growth than fir, it would be best to plant considerable of this in mixture with fir. None of the other native conifers can be recommended for use, and no native hardwoods occur locally, However, two hardwoods are indigenous to this general region which might be used, BLACK COTTONWOOD (Populous trichocarpa) and OREGON ASH (Fraxinus oregona). They are both suited to moist, loamy soil, and would do better than any other species on certain small areas. The cottonwood is a fast grower, gives a clear bole, and the wood is even now quite valuable for cooperage and will probably be used very extensively for pulp. The ash is also a fairly fast grower and the wood is used for small stock and also for lumber and commands a good price.

There are also several eastern species which are well suited to the natural conditions here and which yield very valuable products. Although planting them would be to a certain degree experimental, enough is known to be certain that they will yield a good return on the investment and the following species are recommended for use: EASTERN WHITE PINE (Pinus strobus). This is the only eastern conifer recommended. Its product is extremely valuable, it is a fairly fast grower, is well adapted to the same requirements as Douglas fir and should be planted in mixture with it, the same as the western white pine.

Several species of the hardwoods may be tried out. BLACK WALNUT (Juglans nigra). A fast grower, yielding the most valuable wood of any tree in the country. Should be planted on good, rich soil, in mixture with other species, preferably Oak. After once being started, it can be managed on a coppice system. HICKORY (Hicoria ovata and H. glabra). These two species should be the best of the hickories. They require deep, rich, fresh soil, and make a fairly fast growth after starting. They can later be managed on a coppice system, with a faster rate of growth. A peculiarity is that the fast growth sapwood is the more valuable and is greatly used for small stock, as tool handles, spokes, vehicle construction, etc. As no hickory grows on the coast, it should prove very valuable. YELLOW POPLAR (Liriodendron tulipifera) and BASSWOOD (Tilia americana) would prove valuable. Both are fast growers, prune themselves well and require a deep, fresh, fairly rich soil. The wood of both species is light, soft and straight grained. Yellow poplar is very valuable for many uses and commands a good market, while basswood is nearly as good, and also makes a good wood for pulp. In addition to these it might prove well to try some experimental work with some foreign species, though none are planned for now.

SECTION IV.

General Results.

The future returns to be derived from this work of reforestation may be divided into two main classes, which may be designated as "VOLUME" and "VALUE." Under the head of "Volume" will be considered the actual results in the form of timber produced, while under the head of "Value" will be considered the financial returns—what factors influence them and the aim that it is desired to attain. Following these two main heads will be a general summary of all results and benefits to be derived from this work, financial and otherwise.

Future Volume Returns.

It is, of course, necessary to be able to tell what amount of timber can be grown in any period of time upon any given site in order to forecast closely the future returns. Such work is done by the compilation of what are known as "Yield Tables," which give the amount of timber that can be grown at any period upon any site quality. Of course, individual tree species require individual yield tables. But little work of this kind has been done as yet in this country, as it involves a great deal of time and expense and the covering of a large territory in order to secure sufficient data to compile an accurate table.

However, the importance of Douglas fir, especially in its relation to the future for this very work of reforestation, is so well recognized that for several years past the United States Forest Service has been gathering data on its growth and has now compiled a very accurate set of yield tables. This work was first started by Mr. T. T. Munger and his results published in 1911 in Circular 175 of the Forest Service entitled "The Growth and Management of Douglas Fir In the Pacific Northwest." Since then the work has been still further carried on in greater detail by Mr. E. J. Hanzlik of the Forest Service and the result of his studies published under the title of "A Study of the Growth and Yield of Douglas Fir on Various Site Qualities In Western Washington and Oregon." The figures here given in Tables 1, 2 and 3, 4, 5 and 6 are those in Mr. Hanzlik's report and due acknowledgment of the work of the Forest Service is made at this time.

The work was carried on in western Washington and Oregon west of the Cascade Mountains. About 61 tracts were examined in over 35 different localities and, altogether, 598 sample plots were laid out and measured. The data compiled can therefore be taken as a good, fair average of the yield obtainable. The different site qualities as they were classified for this study are the ones that have been used in this report as mentioned in Section 1.

This study included all types of Douglas fir stands so long as they were pure, even aged, fully stocked and under 140 years of age. The figures indicate the average and not the maximum results which are obtainable and are therefore conservative when applied to proper site qualities. The results as given should approximate fairly closely the results obtainable when Douglas fir is properly managed; if any different, the results obtained, especially as regards quality, which, of course, can not be shown in the tables, should be somewhat better.

The yield tables mentioned are Tables 1, 2, 3, 4, 5 and 6, immediately following.

TABLE 1.

Average Yield for Even-aged Stands of Douglas Fir on Quality 1 Soils.

ALL TREES.

Age	Number of trees per acre	Basal area	D. B. H. of Average Tree	Height of Average Tree	Yield per Acre	Average growth per acre in each decade	Mean annual growth per acre
Yrs.		Sq. Ft.	Inches	Feet	Cu. Ft.	Cu. Ft.	Cu. Ft.
20	940	124	5.0	36.0	2,100		105
30	625	162	6.9	61.0	4,000	190	133
40	383	190	9.6	83.5	6,750	275	169
50	275	216	12.0	102.0	9,050	230	181
60	220	241	14.2	117.0	10,800	175	179
60	250	213	12.5	100.0	8,850	148	147
70	190	268	16.1	129.0	12,500	170	178
80	171	294	17.7	139.0	14,200	170	176
90	152	317	19.6	147.5	15,900	170	176
100	136	337	21.3	155.5	17,600	170	175
110	122	354	23.1	163.0	19,200	160	174
120	112	369	24.6	170.0	20,700	150	172
130	105	383	25.9	177.0	22,100	140	170
140	100	396	27.0	184.0	23,400	130	167

Note: Yield in cubic feet includes the contents of the whole stem of all the trees.

TABLE 2.

Average Yield for Even-aged Stands of Douglas Fir on Quality 1 Soils.

Age	Number of trees per acre	Basal area	D. B. H. of average tree	Height of average tree	Yield per acre	Yield per acre	Average annual growth per acre in each decade	Mean annual growth per acre
Yrs.		Sq. Ft.	In.	Ft.	Cu. Ft.	Ft.B.M.	Ft.B.M.	Ft.B.M.
20								
30	36	36	13.6	78.0	1,200			
40	84	96	14.5	98.0	4,000	16,500		413
50	118	159	15.7	115.0	7,500	30,000	1,350	600
60	125	199	17.1	126.5	9,500	44,000	1,400	734
70	128	241	18.6	136.0	11,500	56,500	1,250	807
80	125	265	19.7	144.0	13,500	70,000	1,350	875
90	122	299	21.1	152.0	15,400	85,000	1,500	945
100	117	320	22.4	159.0	16,900	100,000	1,500	1,000
110	111	340	23.7	165.5	18,400	111,500	1,150	1,013
120	105	358	25.0	172.0	19,850	120,500	900	1,003
130	98	370	26.3	178.5	21,250	128,000	750	985
140	93	386	27.6	184.5	22,700	135,000	700	965

Note: Yield in board feet includes only merchantable contents of diameter of 8 inches inside the bark.

TABLE 3.

Average Yield for Even-aged Stands of Douglas Fir on Quality 2 Soils.

ALL TREES.

Age	Number of trees per acre	Basal area	D. B. H. of Average Tree	Height of Average Tree	Yield per Acre	Average growth per acre in each decade	Mean annual growth per acre
Yrs.		Sq. Ft.	Inches	Feet	Cu. Ft.	Cu. Ft.	Cu. Ft.
20	940	94	4.3	31.0	1,730		87
30	625	132	6.3	54.5	3,230	150	118
40	425	163	8.4	76.5	5,450	222	136
60	250	213	12.5	100.0	8,850	148	147
50	312	190	10.6	90.5	7,370	192	147
70	223	235	13.9	108.0	10,000	115	143
80	210	256	15.0	114.0	11,150	115	139
90	203	276	15.8	120.0	12,250	110	136
100	198	292	16.4	126.0	13,400	115	134
110	196	305	16.9	132.0	14,500	115	132
120	194	316	17.3	137.5	15,650	110	130
130	192	325	17.6	143.0	16,650	100	128
140	190	334	18.0	148.0	17,500	85	125

Note: Yield in cubic feet includes the contents of the whole stem of all the trees.

TABLE 4.

Average Yield for Even-aged Stands of Douglas Fir on Quality 2 Soils.

Age	Number of trees per acre	Basal area	D. B. H. of average tree	Height of average tree	Yield per acre	Yield per acre	Average annual growth per acre in each decade	Mean annual growth per acre
Yrs.		Sq. Ft.	In.	Ft.	Cu. Ft.	Ft.B.M.	Ft.B.M.	Ft.B.M.
20								
30	24	22	12.9	78.0	600			
40	88	89	13.5	96.0	3,350	12,000		300
50	110	134	14.8	107.0	5,550	21,500	950	430
60	120	169	16.2	115.0	7,350	32,000	1,150	534
70	122	197	17.5	122.0	8,850	41,500	950	593
80	118	221	18.6	129.0	10,200	50,000	850	625
90	117	242	19.6	135.0	11,450	58,000	800	640
100	116	260	20.3	141.5	12,600	66,000	800	660
110	115	278	21.0	148.5	13,650	74,000	800	673
120	114	292	21.7	155.0	14,500	81,000	700	673
130	113	307	22.3	161.0	15,300	86,500	550	665
140	112	322	23.0	166.0	16,100	91,500	500	653

Note: Yield in board feet includes only merchantable contents of trees 12 inches or more in diameter at breast height, taken to a top diameter of 8 inches inside the bark.

TABLE 5.

Average Yield for Even-aged Stands of Douglas Fir on Quality 3 Soils.

ALL TREES.

Age	Number of trees per acre	Basal area	D. B. H. of Average Tree	Height of Average Tree	Yield per Acre	Average growth per acre in each decade	Mean annual growth per acre
Yrs.		Sq. Ft.	Inches	Feet	Cu. Ft.	Cu. Ft.	Cu. Ft
20		79			1,320		66
30	1,630	109	3.5	44.0	2,500	118	83
40	775	134	5.6	59.0	4,200	170	105
50	515	157	7.5	70.0	5,650	145	113
60	362	178	9.5	79.0	6,700	105	112
70	286	196	11.1	86.0	7,650	95	109
80	253	211	12.4	92.5	8,570	92	109
90	238	225	13.2	99.0	9,520	95	106
100	233	237	13.6	105.0	10,350	83	103
110	228	246	14.0	111.0	11,100	75	101
120	224	254	14.4	116.5	11,750	65	98
130	219	261	14.8	122.0	12,250	50	94
140	214	267	15.1	127.5	12,700	45	92

Note: Yield in cubic feet includes the contents of the whole stem of all the trees.

TABLE 6.

Average Yield for Even-aged Stands of Douglas Fir on Quality 3 Soils.

Age	Number of trees per acre	Basal area	D. B. H. of average tree	Height of average tree	Yield per acre	Yield per acre	Average annual growth per acre in each decade	Mean annual growth per acre
Yrs.		Sq. Ft.	In.	Ft.	Cu. Ft.	Ft.B.M.	Ft.B.M.	Ft.B.M.
20								
30								
40	14	12	12.5	85.0	350			
50	65	63	13.5	94.0	2,500	9,500		190
60	93	108	15.0	103.5	4,350	16,500	700	275
70	96	144	16.6	112.0	6,000	25,500	900	364
80	98	171	17.9	120.0	7,400	34,000	850	425
90	100	196	19.0	128.0	8,600	42,000	800	467
100	101	213	19.8	135.0	9,600	49,000	700	490
110	100	226	20.4	140.0	10,500	55,500	650	505
120	99	236	20.9	148.0	11,250	60,500	500	504
130	97	244	21.4	154.0	11,950	64,500	400	496
140	96	251	21.8	159.0	12,600	67,500	300	482

Note: Yield in board feet includes only merchantable contents of trees 12 inches or more in diameter at breast height, taken to a top diameter of 8 inches inside the bark.

As one of the principal schemes of utilization is to consist of the marketing of the products obtained from thinnings, or intermediate cuts, made during the rotation, a great deal of study has been given to that particular subject. The results that have been worked out by the writer are original and along a somewhat new line, but are strictly legitimate and logical in their derivation and are also deemed conservative. The method of determination is as follows:

It will be noticed that in Column 2 of Tables 1, 3 and 5, showing the number of trees at each decade, the number, of course, decreases as the stand increases in age, due to the natural death rate among the young trees. Under ordinary conditions in a primeval forest these trees would stand until decayed or blown down and would by their presence materially retard the development of the rest of the stand. In this work it is on a basis of such dying trees that the thinnings are estimated.

As these trees will naturally be the most poorly developed in the stand at each decade, the estimate of their size must be smaller than the size of the average tree. So, in order to be conservative, they were figured on the following basis: Average diameter of trees to be removed as thinnings, 2 inches less than the diameter of the average tree at the same period as shown in Column 4 of the yield tables. The average height has been taken as 20% less than the height of the average tree as shown in Column 5. This is necessary, as these dead trees are naturally the most suppressed. Their volume according as their size fits them for different uses, as mining timbers, piling, etc., has been computed from the volume tables for Douglas fir as given in Circular 175 of the Forest Service. Also in the earlier periods only about 75% of the number of trees which die are reckoned as being merchantable. These reduced estimates both as to size and number of the trees that are to be used as thinnings insure the conservatism of the estimate. The amounts of these thinnings are given in Table No. 7, as follows:

TABLE 7.

Yield Tables for Thinnings from Douglas Fir at Different Periods and on Different Site Qualities.

Age of Stand in Years	Number of Trees Removed in Thinnings	Diameter of Average Trees Removed as Thinnings	Height of Average Trees Removed as Thinnings	Total Volume Removed as Thinnings at each Decade
		NO. 1 QUALITY SITES.		
30	120	5.0	45	3 cords
40	100	7.5	65	2,500 ft. mining timber
50	50	10.0	80	2,000 ft. mining timber
60	30	12.0	90	1,500 ft. mining timber

70	15	14.0	100	750 ft. piling
80	15	15.5	105	900 ft. piling
90	12	17.5	110	3,600 ft. B. M.
100	12	19.0	115	4,200 ft. B. M.

NO. 2 QUALITY SITES

30	100	4.5	40	2.5 cords
40	100	6.5	60	2,000 ft. mining timber
50	50	8.5	75	1,650 ft. mining timber
60	25	10.5	85	1,050 ft. mining timber
70	12	12.0	90	600 ft. mining timber
80	7	13.0	95	300 ft. mining timber

NO. 3 QUALITY SITES.

40	150	4.0	45	3.5 cords
50	125	6.0	55	1,250 ft. mining timber
60	70	7.5	60	1,850 ft. mining timber
70	30	9.0	65	1,000 ft. mining timber
80	15	10.5	70	675 ft. mining timber

Note: First thinning under each case to be made only if market conditions show that it will not prove an expense.

The discussion of prices for the products of these thinnings and their influence on the intensity with which such cuts will be made are taken up in the following subject of "Future Values," as are also the prices for the final cuts at different times.

As far as regards other species that may be grown on the area, little that is definite as concerns their rate of growth can be told. This is especially true as regards such species as are not native to this region, for example: black walnut, hickory, yellow poplar and eastern white pine. It is known, however, that their rates of growth in their natural regions are very good and all indications are such as to lead to the belief that they will do well here.

Douglas fir, however, will form by far the largest part of the new forest and it is sufficient for demonstrating the value of the work to show its results. Data for yield tables on these other species is being constantly compiled and within a few years enough will be known about them to make fairly accurate forecasts of what their future yields should be.

FUTURE VALUES.

Under this head there will be a discussion of future stumpage values with the factors influencing them as well as they can be forecast; a statement of the cost of this special work to the city; a statement of the financial returns that should be derived from it, and a comparison of the cost of this work to the city and to the private individual, showing the great balance in favor of the city.

Some people at this time seem to doubt that there will be a greater increase in the use of wood in the future, or even as great a use as at present, and believe that prices therefor will not materially advance. It is desired to quote the following, merely as an example:

The population of Great Britain and Ireland during the period from 1880 to 1900 increased by about 20%. During the same time the increase in imports of timber was about 45%. In other words, every head of population of 1900 used more timber than 20 years earlier. Germany produced in 1880 about as much timber as she required; in 1899 she imported 4,600,000 tons (probably about 3,000,000,000 feet B. M.), valued at about $68,000,000, and her imports are rapidly increasing, although the yield capacity of her own forests is much higher now than it was formerly.

The increase of population in these countries is not nearly so great as in our own. In fact, our own increase of population is so rapid that even if no more timber is used per capita in the future than at present, our annual cut must be increased in order to meet the increased demand.

Sir William Schlich, the most noted European authority on forestry, states that: "The United States of America will not much longer be a genuine exporting country, since they import already almost as much timber from Canada as they export. The only countries which are able to supply coniferous timber for export on a considerable scale are Russia, Sweden, Norway, Austria and Canada. As these countries have practically to supply the rest of the world, and as the management of their forests is far from satisfactory, the question of supplying light pine and fir timber, which forms the very staff of life of the wood industries, must become a very serious matter before many years have passed. Unmistakable signs of the coming crisis are everywhere visible to all who wish to see, and it is difficult to over-state the gravity of the problem!"

The State of Washington at present leads all states in the amount of timber cut, the annual cut averaging about 4,500,000,000 feet B. M., or a little over 10% of the entire lumber cut of the United States. At such a rate, it will not be long before her forests will be practically gone. The influence of the Panama Canal will in all probability be such as to increase the rapidity of cutting. Times now are not as they were when the great forests of the Northern Lake States were being cut. Then the Pacific Coast, with its wealth of material, offered at low prices, furnished a supply which has since had the effect of keeping prices fairly low. When this timber is gone, there being no virgin supply to fall back upon, there will be an inevitable rise in price.

This may be demonstrated in several ways:

First, there may be made a comparison with the rise in prices of stumpage during the past, of which the following instances may be quoted:

Hemlock in Pennsylvania in 1865 was counted a waste product. Now it is worth from $6 to $8 per M. feet. Long leaf yellow pine in Missouri in 1880 was sold by the acre at an average price of 10 cents per M. feet. In 1899 it was worth $1.00 per M. and in 1907 was worth $3.15 per M.

But perhaps the best example of all is that of the famous white pine in the Upper Lake States. In 1866 it could be bought for $1.25 to $2.50 per acre. In the early seventies it reached $1.00 per M.; about 1890 it brought $5.00 per M.; about 1900, $8.00 per M.; and in 1910 the average price in upper Michigan was $14.50 per M. Douglas fir in this region presents a case almost analogous to that of the white pine, and it is safe to say that a similar relative increase in prices will occur here. In fact, it is more than probable that the increase in prices will be much greater, due to the fact, before mentioned, that there is no fresh supply to fall back upon.

Second, by computing the cost to an owner of acquiring timber now and holding it for a future market at, say, 80 years from now. Good stumpage cannot be bought at the present time for less than $2.00 per M. feet. If held 80 years and the owner desires to make 5% interest on his investment, the stumpage price at that future time would have to be $99.12 per M. and this figure does not take into account any such item as taxes, protection, etc. Including these items, the price would have to be at least $125 per M. As this shows the utter impracticability of holding timber now acquired, it follows that such timber must be cut, and cut soon, in order to realize a profit. This will result in the early removal of practically all of the enormous stands of mature timber now existing in Oregon and Washington.

Future supplies must then be obtained by the operations of reforestation, or the growing of timber.

The **third** method of comparison is based upon the fact that in the future timber must be grown, as is any other crop, to supply the increasing demands of the future. The cost to private parties, of growing timber, is greater than the cost to the city or to other municipal corporations. Approximately four-fifths of the timber in the United States now belongs to private owners. If the same ratio obtains in the future, the price of timber will be determined largely by the cost to private parties of the growing of the timber. If the land suitable for reforestation eventually becomes to a greater extent the property of municipal corporations, the price of timber will more nearly approach the cost to municipal corporations of the growing of the timber, plus a reasonable percentage for profit. In any case, if the use of timber continues, its market price in the future will represent the cost to the municipality of growing the timber, plus an amount varying from a reasonable percentage of that cost to an amount representing the difference in the cost to the private owner over and above that to the municipality. In order to show what this difference of cost may be, the following Tables Nos. 8, 9 and 10 are submitted. The remarkable advantage to the municipality, it may be pointed out, lies in the fact of its being relieved of the payment of taxes:

TABLE 8

Per Acre Cost of Growing Timber Upon Cedar River Watershed Under Municipal Ownership

Average cost of stocking, $9.25 per acre. Administration and protection, 5 cents per acre per annum. No taxes. No initial land cost. Interest rate, 4½%, compounded annually. Final yield taken as average of Qualities 1, 2 and 3, in proportion as they occur on the lower watershed, viz.: 8% No. 1, 70% No. 2, and 22% No. 3 site quality.

(1) Age in Yrs.	(2) Cost of Stocking. with accumulation of interest	(3) Administration and protection with interest	(4) Total Cost of Work at each decade	(5) Yield in Ft. B. M. per acre	(6) Cost per M. Ft. for growing timber
40	$ 53.80	$ 5.35	$ 59.15	9,600	$ 6.16
50	83.54	8.92	92.46	19,500	4.74
60	129.75	14.47	144.22	29,500	4.89
70	201.50	23.09	224.59	39,100	5.74
80	312.93	36.47	349.40	48,000	7.28
90	485.97	57.26	543.23	56,600	9.60
100	754.69	89.54	844.23	64,900	13.01

The following Tables Nos. 9 and 10, showing cost of growing timber under private ownership, are based upon the assumption that the land is composed of 50% of No. 1 quality site, and 50% of No. 2 quality site. This gives a greater yield per acre than in the case of the lands in the lower watershed, as in Table No. 8. It is believed that this is a fair assumption, for the reason that the returns from No. 3 quality sites would be too low to warrant reforestation under private ownership.

TABLE 9.

Per Acre Cost of Growing Timber Under Private Ownership.

Cost of land, $2.50 per acre. Average cost of stocking, $7.50 per acre (exceptionally low). Interest rate, 5%, compounded annually. Taxes at 1% of real value (substantially the present rate of taxation). Up to 40 years, real value is considered $10 per acre; thereafter, it is considered as the real cost of growing the timber, with a re-assessment every ten years. Administration and protection, 5 cents per acre per annum. Yields are average of No. 1 and No. 2 quality sites.

(1) Yrs.	(2) Cost of land and stocking with accumulated interest	(3) Administion and protection with accumulated interest	(4) Taxes	(5) Total cost of growing timber at each decade	(6) Final yield at each decade in Ft. BM.	(7) growing timber Cost perM. ft for
40	$ 67.90	$ 6.04	$ 12.08	$ 86.02	14,200	$ 6.06
50	112.17	10.47	30.81	153.45	25,700	5.97
60	184.29	17.68	69.80	271.77	38,000	7.15
70	301.76	29.43	148.19	479.38	49,000	9.79
80	493.11	48.56	302.00	843.67	60,000	14.06
90	804.80	79.73	598.36	1,482.89	71,500	20.74
100	1,312.51	130.50	1,161.50	2,604.51	83,000	31.38

It will be observed from Table No. 9 that the general property tax takes an increasing proportion of the total cost, and must sooner or later force the cutting of the timber.

It is believed that the present system of taxation, as applied to standing timber, is inequitable and must give place to a system requiring the payment of the tax upon timber when the timber is harvested. This tax will fall at a time when the owner is best able to pay, and will not have the tendency to force the owner to cut before the timber has reached the most profitable cutting stage.

For the purposes of comparison, Table No. 10 has been computed in accordance with the above system of yield tax. With the interest rate at 5%, the final tax must be 20% to yield a return equivalent to a 1% annual tax.

TABLE 10.

Cost of Growing Timber under Private Ownership.

Cost of land, $2.50 per acre. Average cost of stocking, $7.50 per acre (exceptionally low). Interest rate, 5%, compounded annually. No annual tax, but final tax equivalent to 20% of final yield. Administration and protection, 5 cents per acre per annum. Yields are average of Nos. 1 and 2 quality sites.

Age in Yrs.	Cost of land and stocking with accumulated interest	Administion and protection with accumulated interest	Taxes	Total cost of growing timber at each decade	Final yield at each decade (80% of real yield) in Ft. B. M.	Cost per M. ft. for growing timber
40	$ 67.90	$ 6.04		$ 73.94	11,400	$ 6.49
50	112.17	10.47	20%	122.64	20,600	5.95
60	184.29	17.68	of	201.97	30,400	6.64
70	301.76	29.43	final	331.19	39,200	8.45
80	493.11	48.56	yield.	541.67	48,000	11.28
90	804.80	79.73		884.53	57,200	15.46
100	1,312.51	130.50		1,443.01	66,400	21.73

In preparing these tables, no reduction of cost by reason of revenues from thinnings has been made, for the reason that the receipts from thinnings may be expected to vary with the location of the reforested lands with respect to markets, and with the topography and physical condition of the lands. The values given in the tables are relative values for comparative purposes.

For the purpose of estimating the probable returns to the city from the sale of timber grown upon the lower watershed, a series of stumpage values at periods of ten years has been used in this report, as follows:

TABLE 11.

Years.	Stumpage Value Per M. Ft. B. M.
40	$ 4.00
50	5.00
60	6.00
70	8.00
80	9.00
90	10.00
100	11.00

For the purpose of comparing the estimated stumpage values given in Table No. 11, with the cost of growing timber under different conditions, the following Table No. 12 is introduced:

TABLE 12.

(1) Age in Years.	(2) Estimated stumpage value per M. ft. B. M.	(3) Cost to city of growing timber per M. ft. B. M.	(4) Cost under private ownership, present system of taxation, per M. ft. B. M.	(5) Cost under private ownership, modified yield tax system, per M. ft. B. M.
40	$ 4.00	$ 6.06	$ 6.06	$ 6.49
50	5.00	4.74	5.97	5.95
60	6.00	4.89	7.15	6.46
70	8.00	5.74	9.79	8.45
80	9.00	7.28	14.06	11.28
90	10.00	9.60	20.74	15.46
100	11.00	13.01	31.38	21.73

Expressed in percentages of the cost to the city of growing timber, the results are as follows:

TABLE 13.

(1) Age in Years.	(2) Estimated stumpage value per M. ft. B. M.	(3) Cost to city of growing timber per M. ft. B. M.	(4) Cost under private ownership, present system of taxation, per M. ft. B. M.	(5) Cost under private ownership, modified yield tax system, per M. ft. B. M.
	Per cent	Per cent	Per cent	Per cent
40	64.9	100	98.4	105.4
50	105.5	100	125.9	125.5
60	122.7	100	146.2	135.8
70	139.4	100	170.6	147.2
80	123.6	100	193.1	154.9
90	104.2	100	216.0	161.0
100	84.6	100	241.2	167.0

Expressed in percentages of the estimated stumpage values, the results are as follows:

TABLE 14.

(1) Age in Years.	(2) Estimated stumpage value per M. ft. B. M.	(3) Cost to city of growing timber, per M. ft. B. M.	(4) Cost under private ownership, present system of taxation, per M. ft. B. M.	(5) Cost under private ownership, modified yield tax system, per M. ft. B. M.
	Per cent	Per cent	Per cent	Per cent
40	100	154.0	151.5	162.2
50	100	94.8	119.4	119.0
60	100	81.5	119.2	110.7
70	100	71.8	122.4	105.6
80	100	80.9	156.2	125.3
90	100	96.0	207.4	154.6
100	100	118.3	285.3	197.5

It will be evident from an inspection of the above tables that the stumpage values estimated at different periods in the future are conservative. These figures, however, do not take into account any returns that may be derived from thinnings and it is there that the secret of profit lies. Other parties may not be able to make such thinnings on account of a lack of a proper location as regards market and, as shown later, the lower watershed has an ideal location for this purpose. But even leaving this subject out of the consideration, it can be seen that the city can grow timber much cheaper than private parties. And it is the cost of such growing that will to a large extent influence future stumpage prices.

In fact, the main tendency of the future to hold down stumpage prices will come from the following sources: First, the National forests, from which, by the present practice of storing up vast quantities of timber, the United States will, in the future, be in a position to sell this timber cheaper and so keep the price down, provided that policy is adopted by the Government. Second, the state lands, in case the state, as is now proposed, reforests its logged-off lands and sells its future product. The ability to sell cheaper in both these cases comes from the fact that the National and State Government are able to secure money at a low rate of interest and, above all, pay no taxes. The City of Seattle will be, however, in a position to meet competition from such sources. Third, importations from foreign countries, whose timber supply is at present undeveloped. Such imports will, to a certain degree, tend to keep prices low, but cannot prevent a rapid rate of increase in stumpage prices at some time in the relativelv near future.

Bearing in mind the facts and figures given above, the estimated stumpage values as used in forecasting future results given in Table No. 11 will be seen to be a minimum. There is no doubt in the minds of those who are conversant with the economic conditions of the timber supply of the country and of the increasing demand for timber that these figures are ultra conservative. It is the writer's personal opinion from his knowledge of the markets in this vicinity that the future financial returns will, in all probability, be at least 20% greater than those given in the money yield tables. It may be remarked here that a peculiarity which has since become an axiom in European forestry, where time has had a chance to prove all theories, is this: "All predictions as regards future prices, however wild at the time, have always and invariably proven too low."

Following such a line it might be well to quote here a few examples of European stumpage prices.. Silver fir and Norway spruce in the famous Black Forest in Germany, in regions difficult to log, and standing only about 40,000 feet to the acre at 100 years of age, are valued at from $18.00 to $30.00 per M., according to location. Scotch pine in the valleys, accessible, but in comparatively poor stands, is worth $25.00 to $30.00 per M. The finest white oak in the Spessart Mountains is worth from $100.00 to $175.00 per M. and is sold by the individual log. Southern yellow pine lumber imported from New Orleans sells in Mannheim at $50.00 per M. While it is not at all meant to suppose such prices here, these figures are given merely to show at what prices stumpage may be sold eventually, and, in comparing all factors, to show the conservatism of the figures used in this report.

As the future value of the timber depends to a large extent upon the location of the area and its proximity to the market, this subject has been given due consideration, and a description of the area, from an economic standpoint, is here given.

INDUSTRIES AND ALLIED ECONOMIC SUBJECTS.

The first point is, of course, the accessibility of the land, which, to a large extent, determines whether or not the product can be marketed at a profit. No shipping point in this lower watershed is more than forty miles from Seattle, so the freight rates to the market will be very low. In addition there are several small towns, which are generally great lumber consumers, all within radius of a short shipping distance, so that from the point of freight rates there will be no difficulty in securing an ample market.

Two railroads now cross the area, the Chicago, Milwaukee & St. Paul Ry. from east to west, and the Green River branch of the Northern Pacific, from north to south, while the Columbia & Puget Sound Railway extends to the town of Taylor in the northwestern part of the watershed. Such railroad connections afford ample shipping facilities from all parts of the area and it will not be necessary to have to locate a large central shipping point.

While there is ample market for all of the lumber to be taken out as the final cut at the end of the rotation period, the great advantage in the location of this area is its proximity to a ready market for all such material as will be taken out in the intermediate cuts or thinnings. And it is the revenue from the sale of such material that gives the opportunity for a large profit on the enterprise.

In other operations this material is generally disposed of as pulp wood, firewood, railroad ties, etc., at a fair price. Here, however, there is a large market in the future for the consumption of this material in a form which will bring in a much better price. It is indeed doubtful if there is any other location in the state which affords the opportunity for the full utilization of such material at as good prices as can be obtained here. The point referred to is the demand for mining timbers in this immediate vicinity.

On the watershed itself there is the town of Taylor, with the works of the Denny-Renton Clay & Coal Co. This offers a ready market right at hand for a partial consumption of some of the mining timbers. At Renton there are the mines of the Puget Sound Traction, Light & Power Co. At New Castle, Ravensdale and Black Diamond there are also several coal mines belonging to the Northwestern Improvement Co., and the Pacific Coast Coal Company, and there exist within the immediate vicinity great deposits of coal at present unused, awaiting the time when economic conditions will justify their development. All these mines are within a short shipping distance of the watershed and all can be reached by the Columbia & Puget Sound Railway, the Northern Pacific Railway, or the Chicago, Milwaukee & St. Paul Railway. This fact of being able to ship direct from Taylor to these mines by the Columbia & Puget Sound Railroad is one of the main reasons, as mentioned earlier, for starting the first operations on the lands in the vicinity of Taylor.

As to the future consumption of mining timbers by these companies, there is no doubt of the market afforded by them. That timber must be used for this work is admitted, and already the source of the future supply is a subject of some speculation. Interviews with men of these companies have brought forth the opinion that there is no doubt of the future market for this class of material, and that the prices for it will steadily increase.

At about sixty years it may pay better to take out the material in the form of piling, and there will always be a ready market for such material here in Seattle. It may also develop in the future that the prices of certain specific products may rise to such a degree as to make it more profitable to make these thinnings in other forms, as railroad ties, pulp wood, etc. If such should be the case, such arrangements can easily be made and the only effect on the financial returns would be to increase them, for unless it did mean such an increase the present idea of cutting mining timbers would be adhered to.

Another factor also of great importance is the extent to which the area is already opened up by logging roads. Old railroad grades, skid roads, fore and aft roads, pole chutes, etc., are found in all parts of the area, having been put in when the timber was originally logged. In addition there are the railroad grades being used by the lumber companies now operating, and there will also be the grades and roads that they will put in in the future.

As transportation charges, which include all the original cost of the construction of such grades, are perhaps the heaviest and most important of all expenses that have to be borne in logging, it can be seen what a great saving it means to have these grades already constructed. Some repair work will have to be done on them when it comes time to use them, but all location expenses will be done away with, and the repair cost will be comparatively low. Indeed, this item of these roads being already in, will mean a saving of thousands of dollars and will render it remunerative to reforest some areas which would otherwise be a doubtful proposition as to whether or not they would pay.

Besides their utility when logging is to be done they will be of present use in the reforesting work itself, as they make the area accessible for pack horses, and in some places for teams, and so facilitate the transportation of material in the field. And also they afford a most excellent basis for the development of systems of fire lines.

The question of labor is one that is, of course, difficult to discuss with any relation to the future, but it is safe to say that with all the small towns in the immediate vicinity, together with the facilities of getting men in Seattle, that there will be no trouble in that regard. The work requires a comparatively small force of men, and those only for a relatively short time, so that the labor question presents no difficulties.

Indeed, considering the two main factors, first, that all routes of transportation in the area are already or will be, to a certain extent, well developed, and, second, that there is right at hand the very best kind of a market for the future products, with shipping facilities leading direct to these markets, the situation of the area is the very best, from the viewpoint of its economic location upon the future financial returns.

ESTIMATE

of Probable Financial Returns to the City of Seattle from the Reforestation of the Lower Watershed.

In the preparation of this estimate, consideration is given to all items bearing upon or influencing the final cost to the city. The revenue to be derived from the timber to be removed at varying intervals for the purpose of thinning the stand is first computed as to each class of sites and the value of the standing timber remaining upon the land at each period after the thinning is also estimated. These figures are given in Table No. 15, following:

TABLE 15.

Showing future values of thinnings and the final cut, at different decades and on all site qualities, according to future stumpage prices as already forecast, per acre.

For Thinnings.

Years.	Total volume of thinnings per acre.	Future price per unit.	Total value of thinnings.
	NO. 1 QUALITY SITE		
30	3 cords		
40	2,500 lin. ft. mining timber	¾c per lin. ft.	$18.75
50	2,000 lin. ft. mining timber	1c per lin. ft.	20.00
60	1,500 lin. ft. mining timber	1¼c per lin. ft.	18.75
70	750 ft. piling	3c per lin. ft.	22.50
80	900 ft. piling	3½c per lin. ft.	31.50
90	3,600 ft. B. M.	$9.00 per M.	32.40
100	4,200 ft. B. M.	10.00 per M.	42.00
	NO. 2 QUALITY SITES		
30	2.5 cords		
40	2,000 lin. ft. mining timber	¾c per lin. ft.	$15.00
50	1,650 lin. ft. mining timber	1c per lin. ft.	16.50
60	1,050 lin. ft. mining timber	1¼c per lin. ft.	13.12
70	600 lin. ft. mining timber	1½c per lin. ft.	9.00
80	300 ft. piling	3½c per lin. ft.	10.50

NO. 3 QUALITY SITES

40	3½ cords	
50	1,250 lin. ft. mining timber--1c per lin. ft.	$12.50
60	1,850 lin. ft. mining timber--1¼c per lin. ft.	23.12
70	1,000 lin. ft. mining timber--1½c per lin. ft.	15.00
80	675 lin. ft. mining timber--1¾c per lin. ft.	11.81

For Final Cut.

Years.	Total volume of final cut per acre.	Future price per M. ft. B. M.	Total value of final cut per acre.
	NO. 1 QUALITY SITES		
40	16,500 ft. B. M.	$ 4.00	$ 66.00
50	30,000 ft. B. M.	5.00	150.00
60	44,000 ft. B. M.	6.00	264.00
70	56,500 ft. B. M.	8.00	452.00
80	70,000 ft. B. M.	9.00	630.00
90	85,000 ft. B. M.	10.00	850.00
100	100,000 ft. B. M.	11.00	1,100.00
110	111,500 ft. B. M.	12.00	1,338.00
120	120,500 ft. B. M.	12.50	1,506.25
	NO. 2 QUALITY SITE		
40	12,000 ft. B. M.	$ 4.00	$ 48.00
50	21,500 ft. B. M.	5.00	107,50
60	32,000 ft. B. M.	6.00	192.00
70	41,500 ft. B. M.	8.00	332.00
80	50,000 ft. B. M.	9.00	450.00
90	58,000 ft. B. M.	10.00	580.00
100	66,000 ft. B. M.	11.00	726.00
110	74,000 ft. B. M.	12.00	888.00
120	81,000 ft. B. M.	12.50	1,012.50
	NO. 3 QUALITY SITE		
50	9,500 ft. B. M.	$ 5.00	$ 74.50
60	16,500 ft. B. M.	6.00	99.00
70	25,500 ft. B. M.	8.00	204.00
80	34,000 ft. B. M.	9.00	306.00
90	42,000 ft. B. M.	10.00	420.00
100	49,000 ft. B. M.	11.00	539.00
110	55,500 ft. B. M.	12.00	666.00
120	60,500 ft. B. M.	12.50	756.25

Table No. 15 shows the computed receipts and values on an acre basis for each site quality. In order to determine the probable receipts and values over the entire area of the lower watershed, in proportion to the relative areas of each site quality, Table No. 16 has been prepared, showing these figures with reference to an acre of average quality.

TABLE 16.

Showing the average receipts from thinnings and the average **value of** the final stand, at various decades, compiled from the values **given in** Table 15, and based on the fact that the lower watershed con**tains** 8% of No. 1 Quality Sites, 70% of No. 2, and 22% of No. 3.

Years.	Average receipts from thinnings per acre.	Average value of final stand per acre.
40	$12.00	$ 38.88
50	15.90	97.70
60	15.77	177.30
70	11.40	313.44
80	12.47	432.72
90	2.59	566.40
100	3.36	714.78
110		875.16
120		995.62

Combining all elements of cost, with interest at 4½ per cent, compounded annually, computed at each ten years period, and deducting the value of the thinnings at each decade, the actual investment value at each period is shown on Table No. 17. There is also given the stumpage value of the standing timber at each period, the net profit or loss to the city and the equivalent net annual revenue per acre of average quality in the lower watershed.

TABLE 17

Showing Itemized Statement of all Costs and Receipts per Average Acre at Each Decade for Entire Lower Watershed.

(1) Age of stand in years.	(2) Summation of total cost of growing timber at each decade	(3) Summation of value of cash receipts from thinnings with interest.	(4) Summation of actual cost of investment at each decade.	(5) Stumpage value of final yield at each decade considered as an asset.	(6) Profit or loss if final cut should be made at any particular period of 10 years.	(7) Equivalent net annual revenue if final cut should be made at any particular 10 yr. period.
	Per acre.	Per acre.	Per acre.	Per acre.	Per acre.	Per acre.
40	$ 59.15	$	$ 59.15	$ 38.88	—$20.27	
50	92.46	18.63	73.83	97.70	+ 23.87	$0.134
60	144.22	53.63	90.59	177.30	86.71	0.300
70	224.59	107.78	116.81	313.44	196.63	0.426
80	349.40	185.08	164.32	432.72	268.40	0.368
90	543.23	306.80	236.43	566.40	329.97	0.288
100	844.23	480.48	363.75	714.78	351.03	0.196
110	1,311.68	751.40	560.28	875.16	314.88	0.113
120	2,037.62	1,166.92	870.70	995.62	124.92	0.029

Note.—For statement of items composing column 2, see columns 2 and 3, and compare with column 4 of Table 8.

An inspection of Table No. 17 will show that the greatest net annual revenue per acre is at the expiration of 70 years. Therefore, the cutting of the timber at approximately that period would result in the greatest profit to the city.

At 70 years, the value of the standing timber is $313.44 per acre. The value of the standing timber on the entire area of the lower watershed, amounting to 31,200 acres, would be $9,779,328.00. The net profit to the city, after deducting the accumulated cost of stocking the land, of the management of the work and the protection of the timber, is $196.53 per acre, or a total of $6,135,000 for the area of 31,200 acres included within the lower watershed.

It should be understood that this value is obtained by the use of the most conservative stumpage values as given in Table No. 11.

For the purpose of showing the returns to the city in case the actual stumpage values are substantially equivalent to the cost of growing timber under private ownership, Table No. 18 has been prepared.

TABLE 18.

Showing statement of costs and receipts per average acre at each decade, for entire lower watershed, based on the relative percentages for both thinnings and final cut, between the prices assumed and those given for the cost under private ownership for growing timber under the modified yield tax system, as shown in column 5 of Table No. 14, and applied to Table No. 16.

(1) Age of stand in years.	(2) Summation of total cost of growing timber at each decade.	(3) Summation of value of cash receipts from thinnings with interest.	(4) Summation of actual cost of investment at each decade.	(5) Stumpage value of final yield at each decade considered as an asset.	(6) Profit or loss if final cut should be made at any particular period of 10 years.	(7) Equivalent net annual revenue if final cut should be made at any particular 10 yr. period.
	Per acre.	Per acre.	Per acre.	Per acre.	Per acre.	Per acre.
40	$ 59.15		$ 59.15	$ 63.06	$ 3.91	$0.036
50	92.46	$ 30.22	62.24	116.26	54.02	0.303
60	144.22	76.31	67.91	196.27	128.36	0.443
70	224.59	145.62	78.97	330.99	252.02	0.545
80	349.40	244.85	104.55	542.20	437.65	0.600
90	543.23	404.51	138.72	875.65	736.93	0.643
100	844.23	634.42	209.81	1,411.69	1,201.88	0.671

Table No. 18 shows that the greatest net annual revenue per acre, under the modified yield tax system, is secured by cutting the timber at some period slightly over 100 years.

For the purposes of comparison with the results given in Table No. 17, a computation of the net profit to the city at the 70-year period is made below.

The value of the standing timber at the 70-year period averages $330.00 per acre, or a total of $10,326,888 for the entire area of 31,200 acres in the lower watershed.

The net profit to the city, after deducting all accumulated costs, is $252.02 per acre, or a total of $7,863,024 for the area within the lower watershed.

Similarly, it may be shown that the estimated net profit to the city, in the case of the maximum stumpage values under the present tax system, at the 70-year period, is $9,426,000.

GENERAL CONCLUSIONS.

1. The proposition of reforesting the Cedar River Watershed is essentially practicable, and there will be no difficulty in creating the new forest. Under proper management and with thorough protection against fire, the future yields of timber should fully equal those forecast in the yield tables.

2. This reforestation will prove to be of very great benefit to the water supply of the city of Seattle, and on that account alone the work may be justified.

3. The work of re-stocking, thinning, logging and protection will provide profitable employment for numbers of men, without necessitating the establishment of a resident population within the watershed.

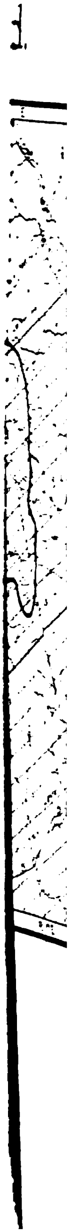
4. Values will be created where otherwise they would never exist. What is now a liability will be converted into an asset of very great value.

5. The creation of the new forest will add to the wealth of the city, and will promote the upbuilding and the advancement of the state.

6. The initial investment required for this work is exceedingly small, and the total cost will be distributed over a number of years.

7. The cost of the work will be returned to the City, together with a profit estimated at from about $6,000,000.00 to $9,000,000.00 by the expiration of a period of seventy years, with a possibility of greatly increased profits at a longer period, if stumpage values then exceed the lowest amount estimated in this report.

8. It is not now apparent that there is any argument against the reforestation of the lower watershed that can be sustained upon any ground other than the initial cost of the investment, and this cost is so small in comparison with the benefits to be derived from this work that it should not be given great weight.



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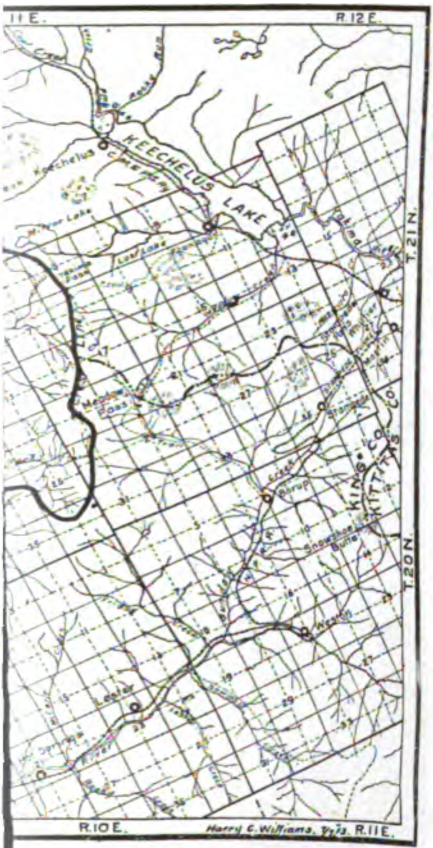

11 E.
R.12 E.
KEECHELUS LAKE
Keechelus
Lost Lake
Meadow Pass
Stampede
Borup
Creek
Snowshoe Butte
KING CO.
KITTITAS CO.
Weston
Lester
River
T.21 N.
T.20 N.
R.10 E.
Harry C. Williams, 7/7/13.
R.11 E.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 228.

Walter Mulford

FOREST PLANTING AND FARM MANAGEMENT.

BY

GEORGE L. CLOTHIER,
ASSISTANT FOREST INSPECTOR, FOREST SERVICE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., August 8, 1905.

SIR: A paper on Forest Planting and Farm Management, prepared under my direction by Mr. George L. Clothier, of the Forest Service, and published in the Yearbook of the Department for 1904, is herewith submitted, with a few slight alterations, for republication as a Farmers' Bulletin.

Respectfully,
GIFFORD PINCHOT,
Forester.

Hon. JAMES WILSON,
Secretary of Agriculture.

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P

FIG. 1. Arrangement of forest plantations on a farm in central Ohio to facilitate scientific farm management........................

2. Ideal plan of the four quarters of a section—suited to the prairies of Kansas and Oklahoma......................................

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FOREST PLANTING AND FARM MANAGEMENT.

FORESTRY AND FARM DESIGNING.

Although agriculture stands first among American industries and our production of farm products is greater than that of any other country, the possibilities of the art of agriculture have hardly begun to be understood. That scientific farming will vastly increase the productive power of the land in the United States is beyond doubt. With the advance of knowledge through the discovery of new truths and the advance in practice through the better application of what science has already found out, improved utilization of the country's resources will make room for a future rapid growth in population and wealth, as expansion in territory has made room in the past. Making the same land twice as productive as before is as good as doubling the amount of land, if not better, and we have as yet scarcely scratched the surface of the agricultural resources of the country as a whole. One of the ways in which present methods of farm management may be greatly improved is by better recognition of what may be called farm engineering, or farm designing; and this in turn must give an important place to the consideration of farm forestry.

The farm designer, or farm architect as he might be called, can do much to improve the efficiency of farm operation. Economical management may be attained by a scientific adjustment of the parts of a farm, just as the utility of a great building may be increased by the careful planning of a qualified architect. Several agricultural colleges and experiment stations have recognized this fact, and have given a distinct place to this as a part of the great problem of how to get the most out of the soil. The best opportunities to apply these principles are found in those parts of the West where new farms are being taken up. Generally it is also in these regions that forestry can do most for the farmer, for in the treeless regions, especially, the full development of the country depends in no small degree on the establishment of forest plantations.

From the fact that trees take so much time to grow, the forester who seeks to advise a farmer how he can make trees contribute most largely to his prosperity is compelled to take a long look ahead to consider the whole problem of farm arrangement. In well-se regions the possibilities of farm designing are apt to be seve limited by what has been done in the past. The location of buildings, the division into fields, and in many cases the situatio the timber, are now fixed facts. Nevertheless, even here a dec improvement may often be made, as will be illustrated later. V needs to be emphasized now is that even in the older parts of country a farm should be run according to a definite and caref considered plan, designed to secure economy of operation and the use of every part; that tree planting for farm purposes ought alv to take into account this plan; and that even where standing tin is already present it may be in the interest of the best use of all p of the farm to cut this down and plant elsewhere.

THE NEED OF FOREST PLANTING.

Forests are indispensable to the highest material developmen any country. We have learned that, besides furnishing the us timber products resulting from the growth of trees, they cons moisture, ameliorate climatic extremes, and purify the atmospl Where they are not found naturally, or where they have been thou lessly removed from wide stretches of country, it becomes desirab behalf of the public welfare to plant trees in great number. O ously the benefits of such plantations will be most widely felt if planting is well distributed over the region. Further, it is a work benefits of which are shared by all, and which all should join in forming.

The plantations in a definite region should be made after one eral plan, in order to allot to each farm its proportionate amoun forest. The method of planting and the position of the planting should evidently be made with reference to a system of farm man ment, since a forest is the most permanent thing that can be pla on a farm. An example of such a plan and such a system is show fig. 1.

MISTAKES OF THE PAST.

It is unfortunate that a large percentage of the plantations mad farmers have been disappointing. Yet some commercial plantati such as that of Mr. L. W. Yaggy, at Hutchinson, Kans., have financially successful.

Farm forest planting has been practiced in some of our pr States for more than half a century, and great good has resulted f many of the plantations, but the measurable increase in the we of the country attributable to forest planting has been small, owin the choice of poor sites and the use of unsuitable species. The artificial forests of Illinois would have been worth many times what they are at present if longer-lived and more valuable species had been used in the plantations instead of silver maple or other trees of as little worth. Species of the greatest value have often been ignored because of their slow growth, and others, deserving to be classed as "weed trees," have been used in their place. Successful plantations of black walnut, hickory, elm, oak, and other valuable trees are common enough to prove that the slower-growing woods ordinarily pay best. Silver maple, boxelder, and the like are valuable chiefly for firewood, and it is easily possible to overstock the market for cordwood in any locality. Lumber woods, on the other hand, can always be disposed of in any quantity.

In order to illustrate the relative values of the two classes, let a comparison be made between the returns from a 64-year-old stand of black walnut in Morgan County, Ill., and a 35-year-old stand of silver maple in Sangamon County. These were the best groves of each species found in the State during an extended survey made in the summer of 1904. The figures relating to the two tracts may be best contrasted in the following table:

Value of planted forests of black walnut and silver maple on the prairies of Illinois.

Species.	Location.	Age.	Area.	Number of trees on area.	Average diameter breast-high.		
					Dominant trees.	Intermediate trees.	Suppressed trees.
		Years.	*Acres.*		*Inches.*	*Inches.*	*Inches.*
Black walnut	Morgan County, Ill	64	0.6	119	19.0	13.3	9.4
Silver maple	Sangamon County, Ill	35	5.6	1,478	10.6	....	....

Species.	Location.	Number of trees per acre.	Yield per acre.			Total value per acre.[b]	Annual value per acre.[c]
			Lumber.[a]	Fence posts.	Firewood.		
			Board ft.		*Cords.*		
Black walnut	Morgan County, Ill	198	42,000	1,800	15	$1,050	$5.58
Silver maple	Sangamon County, Ill	264	....	....	65	130	2.15

[a] From trees 11 inches and over in diameter breasthigh.

[b] Lumber at $20 per 1,000 board feet, fence posts at 10 cents each, and firewood at $2 per cord.

[c] Interest compounded annually at 3 per cent.

It would be quite as easy to show that the returns from hickory, elm, or some other wood which can be used when no older than the maple would amount to more than those from the latter, but the comparison of walnut with maple serves also to emphasize the greater value of a wood which must be kept until the trees attain a good s The figures in the last column represent the annual returns from two plantations irrespective of their age, and are therefore direc comparable.

It is a well-known fact that the great majority of the forest plan tions made in accordance with the timber-culture act were failu Here, again, the unfavorable results were due to poor sites and adapted species, combined with a lack of care on the part of plant and the dishonesty of entrymen, who regarded this law merely a means of obtaining title to public land without paying for it.

Plantations made by specialists and designed for a special purp do not usually require very elaborate planting plans. It is the sm woodlot plantation that is to serve many purposes in the economy the farm which calls for the most careful planning.

PREPARATION OF A PLANTING PLAN.

As a machine of production, a farm should have a plan which p vides for the best use of its every part. The woodlot or forest pl tation should be in a position to contribute to the successful operat of this plan, for the trees may affect the atmospheric drainage, wind currents, and the humidity of the air about the home. At same time a planting plan must provide for sites which will prod the best possible growth. The arrangement of the fields and the lo tion of the fences, private lanes, drainage systems, buildings, a farmstead should all be considered before any forest planting undertaken.

Very rarely indeed have farmers deliberately planned the locati and make-up of their forest plantations with reference to the nee convenience and economy of their farms, and the relative value a adaptability of the trees to be planted. Woodlots have sometin been so poorly located as to do actual damage to farms. Cases ha been observed in the northern half of the Middle West where wi breaks planted too close to the buildings caused the drifting sn of severe winters to bury the houses 15 or 20 feet deep. In the win of 1899 a farmhouse in the Red River Valley, North Dakota, w buried in a snowdrift for three months because a cottonwood gr had been planted too near it. In other cases trees have been plant near tile drains, which the roots clog.

It is probable that not one-tenth of American farms are bei operated under any permanent system of management. Before for planting is undertaken some such system must be adopted, howev in order to make the future existence of the forest plantations pos ble, for more than half the planting plans made since July 1, 18 by the Forest Service, fundamentally affect the future management of the farms. As very few farmers are accustomed to formulating farm plans, the agent of the Forest Service, besides being called upon to give advice in matters pertaining to technical forestry, is usually drafted into this service as well. After consultation with the landholder and consideration of all the matters affected by the policy of management, he is able to bring out an orderly arrangement which will permit on the same farm the practice of both scientific agriculture and scientific forestry.

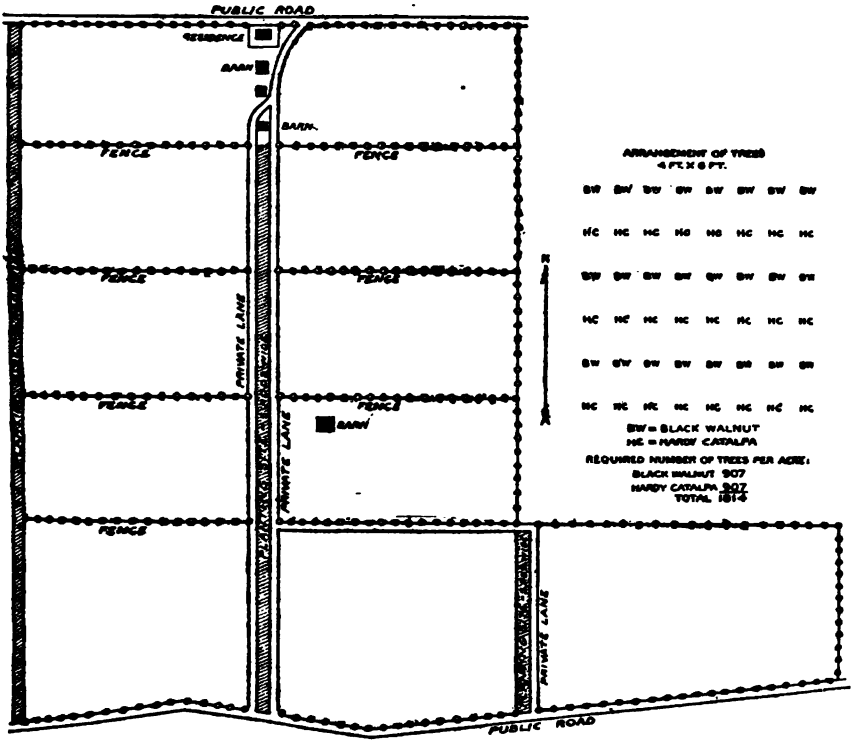

FIG. 1.—Arrangement of forest plantations on a farm in central Ohio to facilitate scientific farm management.

A CONCRETE EXAMPLE.

The planting plan shown in fig. 1 was made for a farm in central Ohio, and illustrates graphically the bearing that forest planting may have on the management of a farm. This farm in Ohio contains 375 acres, and that part of it which is devoted to agriculture is capable of earning interest on a capitalization of $100 per acre; not a foot of it is unsuited to tillage. That part which was originally heavily timbered has all been cleared, except a blue-grass pasture of 30 or 40 acres which is occupied by the remains of the original forest, con ing of a scattered stand of declining sugar maple and beech This timberland embraces the most fertile part of the farm, and i feres most seriously with the convenient and economical divisio the farm into fields. If the Forest Service had advised the o to attempt to rejuvenate the dying trees and to underplant them expensive nursery stock, the instructions would have been impli followed, but such advice would have wrought a positive injury t landholder. Instead, the planting plan advises that the forest ar the farm be reduced by clearing the only natural timber left stan and that, instead of retaining the scattered growth now cumbe the pasture, trees sufficient to occupy about half the present f acreage be planted in such positions as to protect the farm from severe westerly winds prevailing in the region.

The owner was therefore advised as follows:

(1) The major part of this farm is too valuable for agricul purposes to be devoted to forestry. The native timber now scatt over the pasture is rapidly declining, and is reduced by every storm. No natural reproduction is taking place, and while the is grazed none can be secured. The location of the scattered tre the middle of the farm would require expensive fencing in ord protect them from live stock. Thus, it is believed that the rejuv tion of the old forest on this farm is impracticable. Instead, land, as soon as the old trees have all disappeared or been remo should be laid out into permanent fields. As every well-regul farm, however, should possess some timber land to supply it fence posts and to furnish shade and shelter for live stock, new p tations are recommended. The trees will take up as little roo possible, while the arrangement of the fields in rectangular bl will greatly facilitate the use of modern machinery.

(2) The chief plantations should occupy strips 5 rods wide, ning from north to south. One of these strips should be plante the western border of the farm and another crossing its center south of the residence. A third should cut off the block exten east from the southeast corner of the main rectangular tract. addition to these strips, it is advised that single rows of tree planted on the division lines between the fields, so that they ma used as live posts upon which to fasten wire to form fences. fig. 1.)

(3) Black walnut and hardy catalpa should be used in equal portions for the belts, and should be planted every 4 feet in alte ing rows, which should be 6 feet apart. The walnut seed shoul planted two years prior to the introduction of the catalpa seedl in order to allow the slow-growing walnut to get a start before b

crowded by the catalpa. The nuts of the walnut should be collected as soon as ripe in the fall, and should either be stratified[a] in moist sand or planted immediately in their permanent site. These nuts should never be allowed to dry out after ripening. They are most easily planted while plowing, by dropping them in a furrow and covering them with the next furrow slice. If walnuts are thus planted, the squirrels are not likely to find them. The ground between the rows during the following two years should be planted with corn, and should receive good tillage. This can best be done by use of the lister. After the catalpa seedlings are introduced no more corn should be planted, but the ground should be cultivated as long as a single-horse cultivator can be run between the rows. Catalpa seedlings 12 to 16 inches tall and one year old should be used. They can be obtained from dealers for $1.50 to $5 per thousand. The labor of planting these seedlings may be performed chiefly by horsepower. Both walnut and catalpa should be planted in accordance with the diagram shown at the right in fig. 1.

By consulting the illustration the reader will see that the planting plan subdivides this farm into eleven fields—eight rectangular ones of equal area and similar dimensions, and three of nearly equal area but of unlike dimensions. This division will permit the application of scientific crop rotations, the eight rectangular fields being suited to two systems of four-year rotations and the three irregular fields to one three-year rotation. The convenient shape, ease of cultivation, and wonderful fertility of this farm present an excellent opportunity for the arrangement of such rotations of suitable crops.

Trees planted on the lines which separate the fields will serve as windbreaks as well as living fence posts. A method adopted by some is to plant Osage orange hedges between the fields, and every 20 feet to allow one of the trees to grow to its natural height. The remaining trees should be pruned to a height of 5 feet and kept within proper limits for a hedge. Then, if this growth proves inefficient as a fence, it can be reenforced by fencing wire stapled to the large trees. If the Osage orange is undesirable or a hedge is not wanted, chestnut should prove a desirable tree for the fence lines. The young trees should be planted about 20 feet apart, and when they begin to crowd each other every alternate tree should be cut out. Round-headed and with sturdy trunks, these trees will form very effective windbreaks for the intervening fields. Their nuts will bring a satisfactory return for the land they occupy, and the trees which are cut out will furnish excellent fence posts. The substitution of straight woven-wire fences for the old zigzag ones of rails transforms the fence lines from breeding places for noxious weeds into productive land upon which th living fence posts grow into a merchantable product.

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[a] Stratification is a method of storing forest seeds to prevent them from drying out. The seeds are stored in alternating layers between layers of moist sand.

Such a plan as this fixes the boundaries of the fields, locates th private lanes, and, in fact, forms the skeleton of any future system o farm management that may be applied to this farm.

A MODEL PRAIRIE FARM PLAN.

In order to illustrate a model prairie farm plan made in accordanc with sound principles of forestry, fig. 2 has been prepared. Th

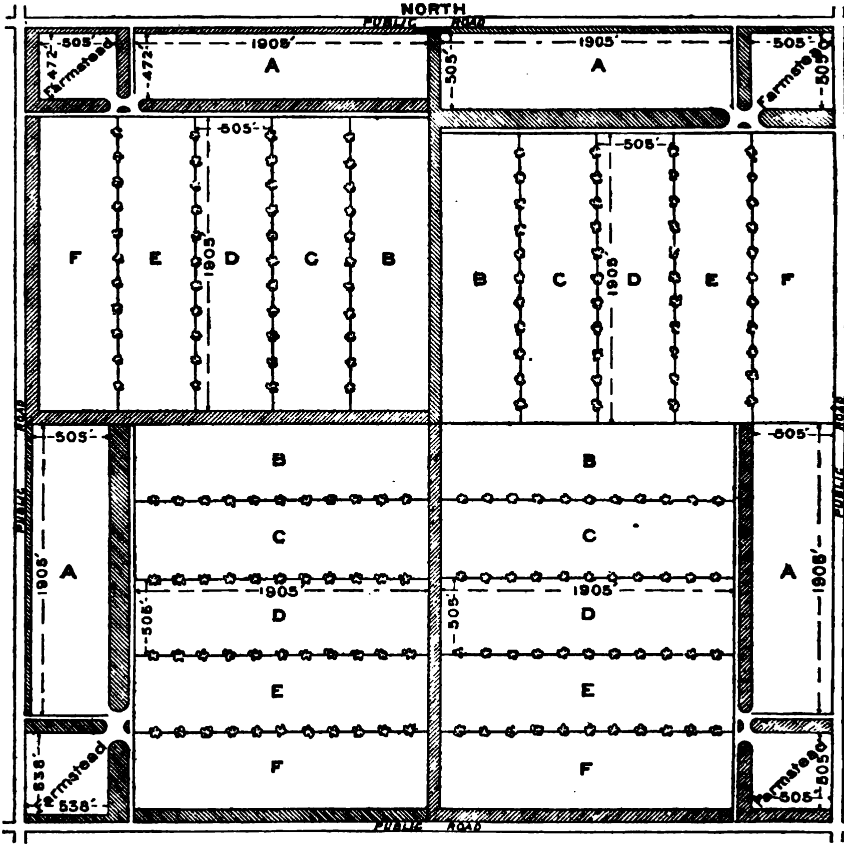

FIG. 2.—Ideal plan of the four quarters of a section with location of forest and win break plantations—suited to the prairies of Kansas and Oklahoma.

farm plan is applicable to a large region in the prairies of the Middl West, where windbreaks are necessary to the full development of th country. It assumes that the land is of uniform condition of soi and has been surveyed by the rectangular system adopted by th Government. The public roads are supposed to be located on th section lines. The application of this model to a country with it surface broken by creeks or lakes would, of course, necessitate a modification to fit local conditions. The plan is intended merely to illustrate principles.

Four farms of 160 acres each are shown, illustrating an arrangement suitable to each of the four quarters of a section. The farmstead, or that portion of a farm which is occupied by the residence, barn, orchards, gardens, lawn, and feedlots, is here shown as placed at the section corner of each farm. While in a large proportion of cases the location of the farmstead will be determined by the particular conditions, as water supply, topography, etc., an arrangement, where practicable, by which the houses stand on the section corners will be worth considering.

The fields on each quarter section have been laid out to permit the planting of windbreaks to protect the crops from the hot southwesterly winds of summer and the cold northwesterly winds of winter. The farmsteads are also provided with protection from winds. East winds have not been considered, because of their infrequent occurrence, but a general adoption of this plan on all the farms of a region would afford protection from all points of the compass.

The fields, with one exception, are all of the same shape and size, there being on each quarter section six fields, each 22.1 acres in area. This method of dividing the farm into fields will afford an opportunity for the application of a scientific system of crop rotation, and the fields, being six in number, will permit the application of a compound rotation embracing the use of a perennial crop like alfalfa in combination with five annual crops, where this is desired. If the use of a perennial is not desirable, the six fields will permit the running of two parallel three-crop rotations.

TREES AND METHODS RECOMMENDED.

The plan provides that the forest trees shall be planted in belts varying from 2 to 8 rods in width, except along fence lines, where they are in single rows. The best results, purely from the standpoint of forestry, will be obtained in the widest belts, since trees are social in their habits. Still better tree growth would be secured by planting in compact blocks. But as agriculture is the fundamental industry in the region to which this plan applies, the tree planting is designed only to supplement the production of field crops. Eleven or 12 per cent of each quarter section is to be devoted to forest. This is exclusive of the space occupied by the single lines of trees in the fence rows.

The species that may be recommended for this purpose vary for each particular locality with conditions of climate, rainfall, and soil. Considering the Middle Western States together, however, the following trees, when placed on hospitable soil fulfilling the re ments of each individual species, may, in the northern half region, be successfully grown as windbreaks:

Arborvitæ.
Green ash.
Boxelder.
Cottonwood.
Cork elm.
White elm.
European larch.
Russian wild olive.
Western yellow pine.
Black Hills spruce.
Laurel-leafed will
Russian golden wil
White willow.

In the southern half of the Middle West, also the green ash, c wood, white elm, Russian wild olive, and western yellow pin be successfully grown, and in addition the following species:

Chinese arborvitæ.
Wild China.
Black locust.
Honey locust.
Mesquite.
Russian mulberry.
Osage orange.
Persimmon.
Shittimwood.

These lists do not include all of the best timber trees that mi grown in the Middle West, for many valuable timber trees wi endure such severe exposure as a windbreak is subject to.

In the establishment of a windbreak wisdom is required i placing of the different species. A windbreak composed of than one species is usually the most effective. An excellent m of arrangement is to place the shortest trees in the outsid (toward the prevailing wind), to plant a somewhat taller s next to them, and to place the tallest trees in a third row on th adjacent to the buildings or the area which is to be protected. causes the wind to strike the trees as it would strike the fac steep hill, deflecting its course upward. If the tallest trees third row consist of a flexible species, such as cottonwood, Eur larch, white willow, or honey locust, they will bend before the and act as a cushion to deflect it upward and over the object protected. A satisfactory windbreak 5 rods in width, for th tection of the north and west sides of a farmstead (see fig. 2 adapted to Minnesota and the Dakotas, is as follows: Plant 13 of trees, parallel to one another and 6 feet 10 inches apart. first two rows on the north and west edges of the belts should of Russian wild olive, the third and fourth rows of arborvit fifth and sixth rows of boxelder, the seventh and eighth ro white elm, the ninth and tenth rows of white willow, and the re ing three rows of common cottonwood. Such a plantation, mature, will appear like a wall with a sloping top, the highes being where the cottonwoods are planted.

Carrying out this same principle for Oklahoma and Texas, change in the position of the plantations to afford protection southwest winds (see fig. 2), the following method is advised first two rows on the south and west edges of the belts should consist of Russian mulberry or Osage orange, the third and fourth rows of Chinese arborvitæ, the fifth and sixth rows of black locust, the seventh and eighth rows of green ash, the ninth and tenth rows of white elm, and the remaining three rows of honey locust or common cottonwood.

In southern California, where the damaging winds come from opposite points of the compass (from both the southwest and northeast), a good plan for a windbreak is one in which the tallest, most flexible trees will be in the center rows, so that the species on either side will slope downward toward the outside edges of the belt. For such a windbreak 2½ rods wide and consisting of 7 rows of trees, the following arrangement may be suggested: The three rows in the middle of the belt should be of blue gum (*Eucalyptus globulus*), the next row toward the outside on each side should be of Monterey pine (*Pinus radiata*), and the two rows occupying the two edges of the belt should be of Monterey cypress (*Cupressus macrocarpa*). This same arrangement may be used on a belt 5 rods wide by doubling the number of rows of pine and cypress and increasing the gum to five rows. In order to construct a windbreak in California that will be perfectly effective, the belts should be placed on all four sides of the area which is to be protected. This is illustrated by the farmstead on the northwest quarter of the section shown in fig. 2.

The belts advised in the model plan are of sufficient width to produce all the timber that will be needed on a farm of 160 acres, while the fields are sufficiently narrow to be protected from winds by the single lines of trees occupying the fence rows. Experiments have demonstrated that a windbreak, on level land, will be effective for a distance of at least ten times its height. For perfect protection on the model farms herein described, the trees in the windbreak must reach a height of at least 50 feet.

An objection to growing trees along fence lines has been made by farmers on the ground that such trees steal the soil nourishment from the crops which are on the edges of the fields. It is true that healthy, vigorous trees make great demands on the soil moisture in their immediate vicinity, but wherever their influence is felt as windbreaks they conserve enough moisture, by preventing rapid evaporation, to more than pay for all that they use. By planting a deep-rooted crop like alfalfa under the shade of the fence-line trees, good returns from the land may be secured in spite of the fact that the trees absorb a part of its moisture. It is a great mistake to begrudge a useful tree the space it occupies, and particularly so in the naturally treeless prairies of the Middle West.

SPECIAL FEATURES OF FOREST PLANTING ABOUT THE FARMSTEAD.

On rare occasions it is found to be impracticable to concentrate different elements of the farmstead in one place. (See fig. 3.) the great majority of cases, however, it is both practicable and nomical to have a farmstead, and the choice of its site is of the importance to the landowner.

If the farmsteads of several adjoining sections were laid out accordance with the plan herein suggested, four farmhouses wo be grouped at each crossroads corner, bringing neighbors togethe a little settlement. The position at the crossroads is also likely facilitate the reaching of church, school, and town. An argum against such an arrangement is the possibility of its leading neighborhood quarrels.

In many cases, however, uniformity of soil does not exist. farmstead must then be located with reference to the adaptability the soil to the forest growth, since a farmstead without trees for sh and shelter is not worthy of the name. The forest planter, theref is often the one to determine the location of a permanent site for farmhouse, and he may also lay out at least the plan of the farmst itself.

Fig. 3, representing the farmstead located on the southeast qu ter of the section sketched in fig. 2, has been prepared to show forest planting may be made to help every one of the different p that go to make up the farmstead. Windbreak belts, 5 rods wide, located on the north, west, and south sides of the farmstead. O spaces varying from 72 to 96 feet in width have been provided to north and west of the buildings and orchards, to act as snow trap catch the drifts during winter storms. Every farmer is familiar the fact that a hedge or belt of trees on the north side of an east-a west road will cause the road to be filled with snow during win when the wind comes from the north. So the open space on the fa stead will in the same way trap the snow, and will consequently vent any drifts from forming near the barn or residence or in orchards. These open spaces may be utilized for garden vegetab sugar beets, and other annual feed crops, the accumulation of wi snows serving as an annual irrigation to store up large quantitie soil moisture for the garden, and making the land particularly adapted to this purpose. The trees on the edges of these spaces for the same reason, grow very vigorously.

In this plan the convenience, health, and comfort of the tenant the farmhouse have all been considered in the location of both b and residence. The grouping of the trees in the background of lawn has been made with reference to adornment, but without an attempt to enter into the details of landscape gardening. The plan leaves the lawn in such a shape, however, that the landscape gardener may have full scope for the display of his talents. A plan including, as this one does, complete protection from the hot winds of summer and the cold storms of winter will add greatly to the intrinsic worth of any farm located in the prairie States. If the farmer is engaged in the production of beef and pork, the protection of the barnyard and feedlots will economize the feed consumed by the fattening animals, for it takes more grain to produce a pound of flesh

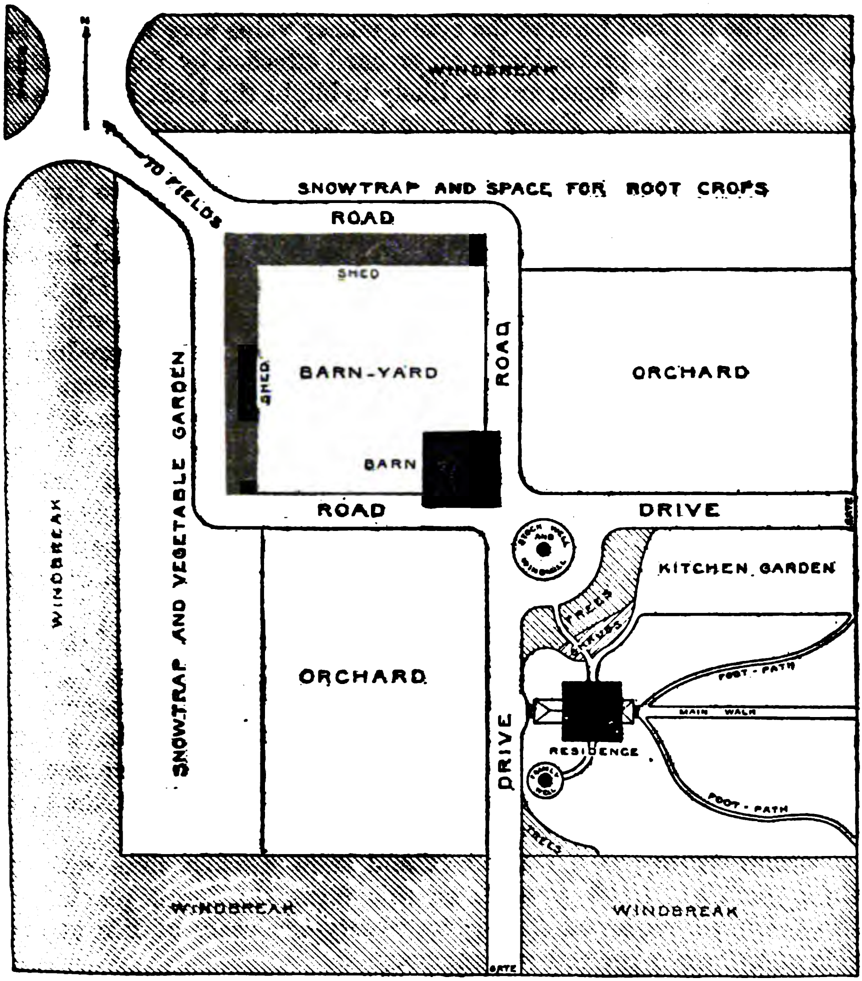

FIG. 3.—Plan of a farmstead, situated at the southeast corner of a prairie farm, arranged to afford windbreak protection.

upon animals exposed to the cold north winds of winter than stock that is protected from blizzards. Thus a windbreak tak place of grain in maintaining the heat of the animal during weather. On the other hand, it will add to the farmer's account during the summer, for it will afford shade and protect fattening animals, which lose flesh in very hot weather.

Windbreak belts in connection with a farmstead form an asse is none the less real because the actual money value may not eas determined. The protection to an orchard afforded by forest t valuable, since late frosts are not likely to blight the fruit blosso a protected orchard. Forest belts on the south and west sides farmstead give ample protection against the parching blasts fro southwest—the hot winds of summer, which are destructive to fr many parts of the country. It is to be understood, however, th forest plantations herein recommended are also to be utilized f production of the needed timber supplies on the farm. By ciously thinning the plantations, 20 acres of planted forest wil nish all the fuel needed on a farm of 160 acres, besides prod lumber for the renewal of the farm buildings. Many Kansa Nebraska farmers have in twenty years grown cottonwood large enough for sawlogs. Mr. W. D. Rippey, of Severance, cut 200,000 feet of cottonwood lumber a few years ago from tr his own planting. Mr. Rippey's plantations were on uplands the soil is not particularly well adapted to the growth of cotton and, when lumbered, were but little more than a quarter of a ce old.

On the farm of Mr. T. F. Eastgate, near Larimore, N. Da the Red River Valley, a belt of planted cottonwood trees, su mented by a dense undergrowth of wild plum bushes, acts as a break and snow catcher, causing a snowdrift to form in over the open field, which is devoted to alfalfa. In the summ 1904 Mr. Eastgate harvested alfalfa hay from this field at th of more than 5 tons per acre.

Besides serving as a windbreak and snow catcher, thus m the growth of alfalfa possible on this farm, the forest plan has produced cordwood during its twenty-one years of life rate of 4.74 cords per acre per annum.

The successful growth of alfalfa on 10 per cent of the area o region would double the earning power of every acre of land Red River Valley; and, since the thermometer here sometimes as low as 50° below zero, it is possible to grow this extremel uable forage only by utilizing some contrivance like Mr. East windbreak, to catch the snowdrifts and form during the wi protecting blanket over the plants.

CONCLUSION.

Forestry is but a branch of the great industry of agriculture, but it can give important aid to the farmer in getting sustenance for the human race from the soil. It has been shown that where forest planting is desirable, the planting plan is of fundamental importance to the management of the farm which is concerned. The location and cultivation of these forests may either make them peculiarly advantageous or cause them to become a detriment to the economical management of the farm.

The planting plans which have been set forth in the preceding pages are not regarded as perfect, but are given as suggestions of what may be done to make farm forest planting serviceable. They are based on considerable practical experience, and it is believed that they demonstrate beyond a doubt how far superior is a well-considered, systematic method of handling the problems of farm forestry to the haphazard, careless methods so often practiced in the past.

Farmers are now receiving instructions from the Department of Agriculture both for the establishment of forest plantations and for the inauguration of cropping systems, but it seldom happens that the same farmer receives instruction in both matters at the same time. The intimate relations existing between farm management and forest planting are so patent and their importance is so great that the two should go hand in hand. It is to be hoped that as the practice of scientific agriculture spreads, model farms may be laid out in all parts of the United States, on which practicable plans for forest planting may be demonstrated and the best methods of planning the various parts of a farm so as to make provision for an economical and practicable system of crop rotation may be illustrated. Farmers, in order to get the services of Government experts in planning both forest plantations and systems of farm management, should make application for instructions both to the Bureau of Plant Industry and to the Forest Service.

FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, sho
the number and title of each. Copies will be sent to any address on applicati
any Senator, Representative, or Delegate in Congress, or to the Secretary of Ag
ture, Washington, D. C.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 134.

TREE PLANTING ON RURAL SCHOOL GROUNDS.

RECEIVED
SEP - 7 1914
Division of Forestry
University of California

BY

WM. L. HALL,

Assistant Superintendent of Tree Planting, Bureau of Forestry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Forestry,
Washington, D. C., July 2, 19

Sir: I have the honor to transmit herewith a paper entitled "Tree Pla on Rural School Grounds," prepared by William L. Hall, Assistant Superin ent of Tree Planting of the Bureau of Forestry, and to recommend its pul tion as a Farmers' Bulletin. The paper deals with the present condition needs of rural school grounds and indicates methods for their improvemen also suggests important lines of study for the teacher and school in conne with trees and forests. The information and advice apply to country ch yards and to school yards in many towns and villages.

As the preparation of this paper involved some consideration of land architecture, the subject of which is outside the province of the Bureau of estry, the paper was referred to Mr. Frederick Law Olmsted, jr., of Mass setts, an authority on landscape architecture, to whom acknowledgment is for valuable suggestions.

Respectfully,
Gifford Pinchot,
Forest

Hon. James Wilson,
Secretary of Agriculture.

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TREE PLANTING ON RURAL SCHOOL GROUNDS.

INTRODUCTION.

A great number of schoolhouses in the United States lack the surroundings that make for comfort and contentment. City school grounds are often so small that planting is out of the question, though where space permits it is not uncommon to find them carefully laid out, with a good arrangement of grass plots, flower beds, and shade trees. In towns and villages, also, may be pointed out many examples showing great care and attention. In the country, however, an improved school ground is rarely found. In hilly, forest regions they are often denuded of soil and full of stones and stumps, and on the prairie many are well-nigh as bare, bleak, and inhospitable as when they formed a part of the unsettled plain.

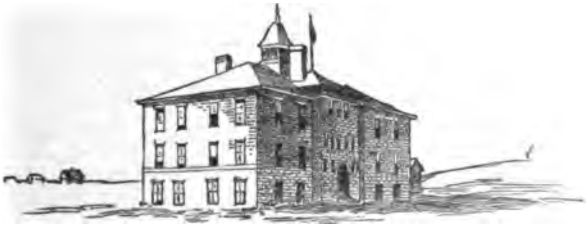
FIG. 1.—A town schoolhouse in a prosperous agricultural region, entirely unprotected.

This lack of improvement is not due to causes evident at first sight. It is not on account of poverty, for it is almost as common in wealthy as in less prosperous communities. (Figs. 1, 2, and 3.) It is not due to lack of appreciation of the elements of beauty, for where homes are surrounded with trees, grass, and flowers the school ground is likely to be entirely neglected. Neither is it due to indifference in educational affairs, for none are more cordial in their support of school systems and institutions of learning than the American people. The cause seems to lie rather in the failure to see the importance of comfort and beauty in education and to realize the interest of the American youth in the natural world around him. Some err so far as to mistrust the willingness of the boys and girls to allow trees and shrubs to grow unmolested on the school ground. This is a flagrant misinterpretation of the spirit of childhood. With a better understanding of youthful nature, one sees an easily awakened regard for things beautiful and a disposition to respect and help all well-directed activities for the improvement of school life.

REASONS FOR SCHOOL-GROUND PLANTING.

Protection.—The strongest reason for school-ground planting is the comfort of the teacher and pupils who occupy the building f seven to nine months each year. A schoolhouse so situated as wh to lack protection from inclement weather often subjects its occupa to distressing conditions. During winter gales there is an increas demand for fuel, which, though supplied, often does not suffic keep the building warm. The teacher is then put to test contri methods by which no pupil shall endure more than his share of c and by which to maintain the usual good order during study h

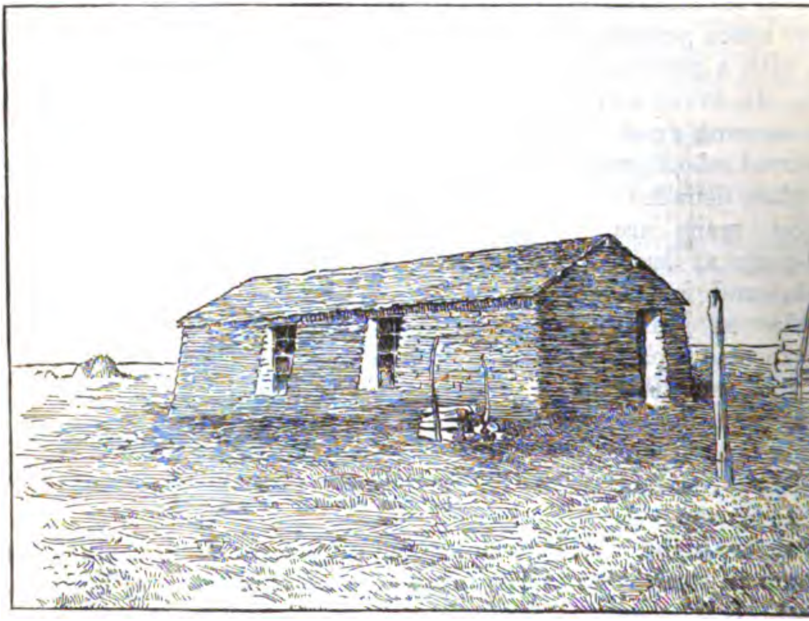

FIG. 2.—Unprotected sod schoolhouse on the Great Plains.

and provide for indoor recreation at the rest periods. With the t perature hovering around the zero point during a howling blizz one has but to enter a country schoolroom to appreciate its discomf and see its need of protection.

The winds of spring are almost as trying as those of winter, in summer the sun beats down with unchecked violence. Thus e season is accompanied by ill effects for those who must attend sc where the grounds are exposed. The question naturally arises: I not these conditions be remedied? To this the answer certa should be that they may. They have been remedied in some instan and can be in others. It is not too much to say that in nine cases of ten exposed school grounds can be rendered comfortable by t planted in wind-breaks.

Educational Value of Trees.—But comfort is not the only reason for planting about the schoolhouse. The trees have also an educational value. Indeed, bare grounds may be regarded as an opportunity. Children interested in the work of selecting, planting, and growing trees and shrubs about the school can gain in the work no little knowledge of right principles and methods. Many people think that to plant a tree all that needs to be done is to dig up a sapling, or buy it, and set it in a hole. This is a great mistake, responsible for many unnecessary failures. Some knowledge of tree culture is a thing sure to prove useful to a large proportion of school children.

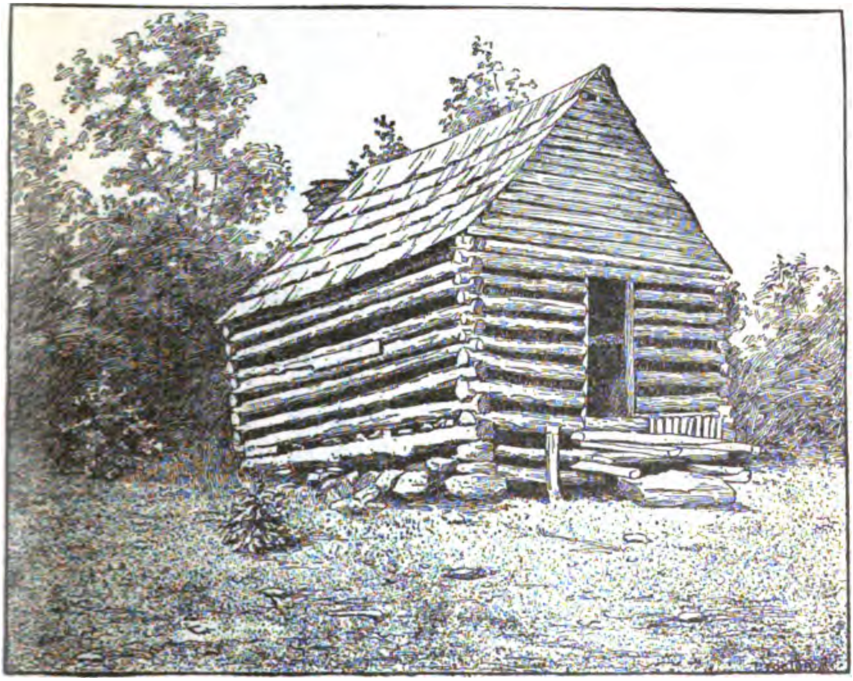

FIG. 3.—Neglected schoolhouse on a forest hillside in the South.

Forestry is beginning to attract attention as a possible subject of school instruction. So far the interest in it is mainly as a branch of nature study, but its growing economic importance may eventually result in its extensive introduction into courses of study. Technical forestry can not be taught in the schools as part of a general education, and it ought not to be supposed that tree planting on school grounds looks in that direction. Nevertheless a plantation of forest trees or a wood lot, in connection with a school, would give an excellent opportunity for study of forest growth and management, and in many places it is perfectly feasible. (Fig. 4.)

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But there is another side to the educational value of tree plantin which is of first importance. It is money well spent to make t schoolhouse and everything about it attractive and beautiful. He is one of the centers of the life of the community, the one in which gathered its most impressionable element. The school is support

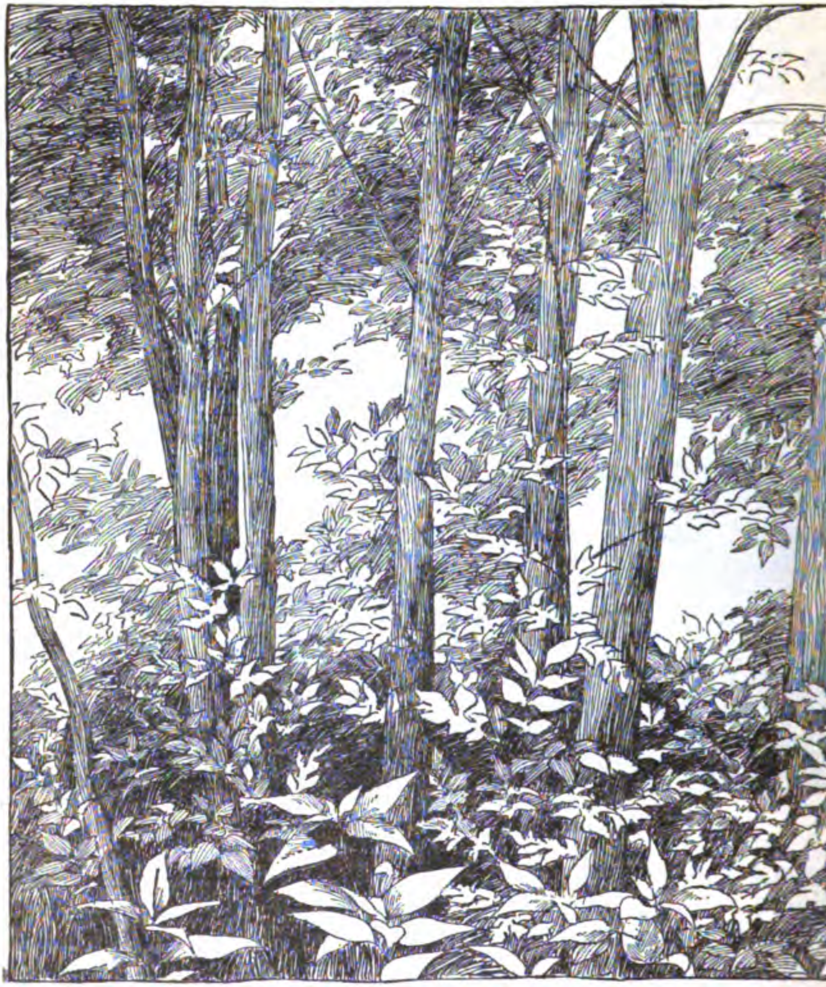

Fig 4.—Interior of a thrifty forest belt, showing an excellent opportunity to study growth of trees.

at public expense in order to make good American citizens. It ai at securing the highest possible development of mind and charact Every element of order, neatness, and beauty, every broadening inf ence, every appeal to the finer nature of the child means better m and women and a more thrifty, prosperous, and attractive communi

Americans are justly proud of their school system, and should be willing to support the schools not only with money but with time and labor.

ARBOR DAY AND SCHOOL-GROUND PLANTING.

The neglected condition of the school ground has not remained without notice or without some effort toward improvement. The sentiment in favor of school-ground comfort and adornment has gradually increased for the last thirty years, and has been greatly aided by the establishment of an annual Arbor Day for tree planting. Arbor Day was proposed by Hon. J. Sterling Morton, ex-Secretary of Agriculture, and was first observed in Nebraska, where it was officially recognized in 1872. It was first associated with school-ground planting in Cincinnati, in 1882, in connection with a meeting of the American Forestry Association. Since then it has been best known by its observance in the schools. All the States have followed the example of Nebraska in establishing Arbor Day, and the movement has now spread into many foreign countries. Great Britain, France, Spain, Japan, and New Zealand all celebrate their Arbor Days.

Method of Celebrating Arbor Day.—The governor of each State annually appoints Arbor Day at the proper season for planting. This day is celebrated in the schools by public exercises appropriate to tree planting, with essays, songs, and recitations by the pupils, and addresses by visitors. In connection with the exercises there is ordinarily more or less tree planting. Great care is taken to make the planting ceremonies impressive by letting the children take part, and by planting trees commemorative of noted persons or events. Much more attention is given to these matters than to having the trees in the best condition and to planting them just right.

As might have been expected, the results upon the school grounds have not been marked. Too often the work has been impulsive and the interest transient. Trees planted with ceremonious dignity in April have died of neglect before September, and those that survived have been left to fight unaided their battles for existence. So little attention has been paid to the choice of trees and to the methods of planting that those entirely unfit for the situation have often been used, and have been planted in places where they could not receive protection while young, or serve any useful purpose when grown. Arbor Day has often come on dry, windy days, or clear out of season for planting. Furthermore, the planting has been on too small a scale to be of great benefit. Where an acre of trees in a solid block is needed, only half a dozen specimens have been planted. After all that has been done, the school grounds are still largely unimproved.

The educational results of Arbor Day endeavors, however, been extensive and beneficial. Even though the celebrations been largely exhibitions of sentiment and the planting almost w unsuccessful, yet pupils, teachers, and parents have learned about trees as useful, living things, and about forests as great so of national wealth to be protected and perpetually maintained. smallness of the results has itself drawn attention to the inadeq of past methods. It is due in part to lessons learned in Arbor planting that we are now ready to begin work with a better u standing of what is to be done.

Necessity for Better Methods.—The need of the school grounds plantations of hardy trees, cared for by such methods as will them constantly thrifty. The trees should be selected and pl in the most careful manner. They should be properly placed in sufficient number. To plant in this way requires a great de attention to details. It may be the work of several days. perishable nature of trees also makes it extremely important to them when the weather conditions are just right. Dry, w weather may cause several days' delay in the planting. It is t fore impracticable to depend wholly on a specified day for the Let the trees be planted at the right time; then, if public exe are planned, they may be held on an appointed day after the p ing is completed.

Many difficulties at present encountered may be overcome by cing the direction of the planting in the hands of some person understands fully its purpose. The pupils should assist in the because it is for their own school ground, but on account of their of experience they should work under competent supervision.

PRELIMINARY ARRANGEMENTS FOR PLANTING.

A movement to improve the school ground is likely to enco many obstacles. The first, and perhaps the most serious, is p indifference. Then there are the difficulties of getting started o right planting plan, of finding methods to carry it out, and of h the planted trees properly cared for during both the school yea the vacation period. These are formidable obstacles, as many sons experienced in school-ground planting will testify; yet have been overcome in a large number of cases, and will con to be overcome, for every school ground successfully planted not only induce other districts to undertake the work, but will the methods by which it may be accomplished.

To be of permanent value the planting must be a matter of co to the whole district. The teacher and the school can not accom the work unaided by the parents, neither can the parents accom it without the aid of the teacher and the school. Only when all work in unison can the best results be obtained. Unfortunately there are sometimes persons in the district who have no interest in improvement, and it may even happen that they control the school board, while those who have an intelligent interest in the matter may be few in number, and even the teacher may be too deficient in knowledge of planting to give valuable assistance; but such a situation as this is not hopeless if the few persons who desire to make improvements know how to bring things about.

The Planting Plan.—The first step is to prepare a plan. This should be a detailed outline of the planting based on a complete analysis of the situation. It should embody a map of the grounds, with the schoolhouse, outbuildings, and place for planting the trees accurately located. If the plan is presented at a meeting in the schoolhouse, a blackboard drawing should be made showing the school ground and exactly what planting is proposed. In this way its advantages can be more clearly pointed out, and its defects, if there be any, will also be pointed out and remedied.

It is scarcely to be expected that a plan will be made which will suit all; so here, as in other matters that concern communities, the majority should rule. It is always to be hoped that the school board, the teacher, and those most active in the improvement of the community will be in perfect accord. If points of difference arise and are not settled after candid discussion, they should be referred to disinterested persons or dropped out of the plan entirely.

A District Policy.—While undue haste in adopting a plan should be carefully avoided, it should be remembered that many good movements fail by not being properly prosecuted. If the district adopts the policy of establishing and permanently maintaining a plantation of trees and shrubs on the school ground for ornament, protection, and improvement, a great advance will have been made; but until this has been done there is no guaranty of lasting results. It is easy to arouse the tree-planting spirit in the school, but unless this interest has the support of the district it is likely to wane and languish. The teacher can not take the responsibility, for his tenure of office is liable to be short. Both teacher and school must be among the chief agencies in carrying out the work, but only according to the general plan, judiciously directed by the district authorities. The appropriate celebration of Arbor Day as a part of the plan will aid greatly in the promotion of education and sentiment in tree planting.

As soon as a policy of planting is adopted, some experienced person should be appointed to superintend the preparation of the ground, the procuring of the trees, the planting, and the subsequent cultivation. Such services must usually be paid for, but they are well worth the cost.

WHAT PLANTING TO DO.

There should be both purpose and method in school-ground pl ing. The trees must be so arranged as best to serve both for pr tion and for ornament. At the same time, to grow well they mu adapted to the soil. On a small ground but little planting is poss a group of trees or shrubs placed where they will look well or some unsightly feature of the schoolhouse or ground is sufficient. in the country there is usually an acre or two of grounds. schoolhouse is nearly always in the middle, and the playground usually about halfway between the building and the outer boun

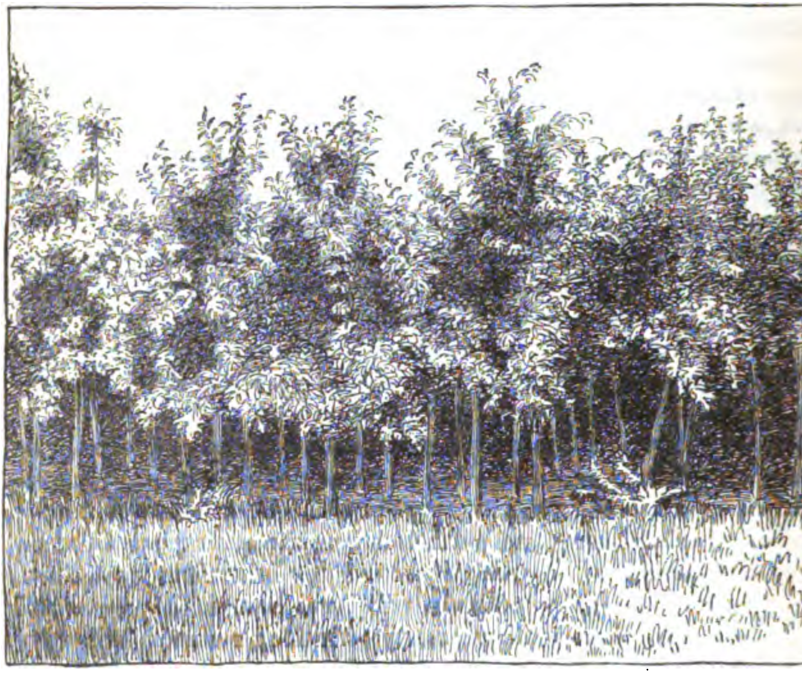

FIG. 5.—A suitable belt for the rear of a school ground.

This arrangement leaves open the outer portions of the gro where the greater part of the planting is needed.

By so planting, the schoolhouse will be protected on all sides the wind, while in summer shade will be provided near all por of the open playground; at the same time inclosing the ground w border of trees will give a pleasing ornamental effect. Instea being continuous around the ground, the border should be broke places to preserve attractive views of the exterior landscape.

The general directions here given may be helpful in affording gestions, but without modification will seldom be fully adapte particular cases. The general condition and size of the grounds, direction of prevailing winds, slope, and surroundings should collectively determine the character of the planting.

A Rear Belt.—In many cases the first necessity is to plant a belt of trees across the rear of the lot. If the ground is large, this may be several rods wide and cover an acre or more. Possibly it may be extended around the outbuildings so as to hide them from view. Solid planting should be the rule. But it often happens that the rear views from a schoolhouse are quite as attractive as those toward the front. In that case the planting must be planned so as to preserve them, while hiding the unattractive features and giving the necessary protection to the ground and building. Fig. 5 shows a good belt of trees for the rear of a school ground, where solid planting is desirable.

Other Planting.—After the rear belt, the side planting is of the most importance. Here again the trees should be in belts. To allow room for a playground, it may be necessary to make the side belts narrower than that in the rear. Openings in them for walks or views of the exterior landscape may also be desirable, but these need not affect the general plan.

A formal arrangement with the trees in straight rows along the sides of the lot will in many instances be appropriate and satisfactory. It gives opportunity for cultivation, and is both simple and attractive. On large grounds a better effect will often be produced by spacing the trees irregularly. Some attention will be required to leave passages open for cultivation without the trees appearing to stand in rows. The appearance of the entire ground will be improved by varying the width of the belts so that they will project into the interior open space in some places, and in others retreat almost to the boundary of the ground.

The front ground in most cases should not be solidly planted. If it is necessary to hide objectionable buildings and other objects on the front and sides or to prevent the trespassing of stock, either a hedge or an irregular belt of shrubbery may be made to serve the purpose. Two or three groups may be introduced where they will not interfere with the playground or obscure attractive views. Fig. 6 shows an entire front yard shaded by trees planted in regular rows. This is a very poor arrangement, for it shuts off the view and robs the children of their playground.

Where several kinds of trees are used in the belts, they should be mixed by groups and not by single trees. Here will be a group of vase-like elms, there a group of sturdy oaks, yonder one of pines. Such grouping gives character to the planting when seen near at

hand, and variety at a distance, where only the tops of the tree
visible, outlined at different heights against the sky.

A little shrubbery rightly used gives a charming effect to a s
yard, although many grounds are well planted without it. It fin
place in clumps against the belts of trees, in corners, and in fro
objects that should not be in view. Banked against the tall tre
tall-growing forms may be used, but around objects to be scr
from view the shrubs should be only high enough to answer the

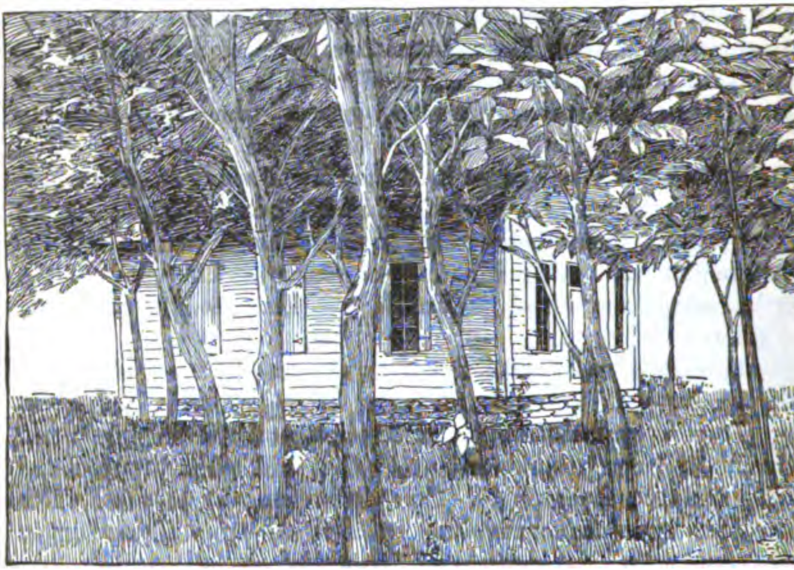

FIG. 6.—Front ground heavily shaded, rear ground open—a poor arrangemen

pose. If planted around the house to hide a rough foundation
only low-growing forms should be chosen.

KINDS OF TREES TO PLANT.

Persons unskilled in planting are apt to choose inappropriate
Fancy leads them to use odd kinds and to form grotesque com
tions which fulfill none of the purposes of planting. Besides, th
of such trees is likely to be very costly on account of the high p
charged for them and the labor required to make them grow. F
nately, the best trees for planting are easily obtained, because
are usually those common in the locality.

Hardy Trees.—The first rule to lay down is to plant only the
that are known to be hardy. A school-ground plantation is no
for experiment. Naturally the trees will have to endure greater

ships than those of a private plantation; they will be likely to have less cultivation and be subject to more abuse. No matter how strict the rules, the soil about them will be more or less trampled, and twigs will sometimes be broken from their tops. Any tree that can not endure moderate abuse of this kind should not be given a place on the school ground.

On account of difference in the soil, a tree that thrives in one place in a locality may not thrive in another place. Sandy soils and clay soils are often found near together, and trees that grow thriftily in sandy soil may have a hard struggle to exist when planted in clay. For this reason both the soil and the subsoil of the school ground should be carefully examined, and a list should be made of trees in the neighborhood that are thriving on soils of the same character, and no other species should be used. Much better success may be expected with a soil and subsoil of a porous character than with one that is tenacious and impenetrable. Yet a careful study will show numerous species adapted to each kind of soil.

Trees Easily Obtained.—Elms, oaks, and maples are to be had almost anywhere, and are easily transplanted. They are as beautiful as any trees to be found, and are in every way well adapted for the school grond. They grow on a great variety of soils, and can be easily raised from seed if young trees are not available. Every region will afford other valuable sorts, such as beeches, chestnuts, walnuts, ashes, pines, or spruces. From these and such other desirable kinds as the locality affords the selection should be made.

Short and Long Lived Trees.—The school ground being permanent and the need of trees continuous, for the most part long-lived trees should be used. But where the present need of trees is great, there is another side to the question. A short-lived tree grows quickly, coming into early usefulness, and serves its purpose for from twenty-five to fifty years. A long-lived tree usually grows more slowly, but serves its purpose for a century or more. In many cases it is advisable to use the two kinds in such a way that the long-lived trees will become useful about the time the short-lived trees reach maturity. The latter can then be removed, leaving the ground to the long-lived trees. In all cases an ultimate stand of such trees as elms, oaks, walnuts, or chestnuts should be the aim.

A Variety of Species.—It may seem that the number of kinds which can be used for school-ground planting is small, but this is not the case. In almost all sections of the country a long list of species fully adapted to the purpose can be made out. In selecting among these the aim should be to give the plantation as much variety as possible, since among other purposes it is to serve that of instruction.

OBTAINING THE TREES.

Forest Seedlings.—In many places trees can be obtained from neighboring forest, from the banks of streams, from plantation even from open fields. If they have had normal conditions of gr and are taken at the right time, they are almost as valuable for p ing as nursery-grown seedlings. Pine, spruce, and cedar are t collected in unlimited numbers in many forests, and frequently maple, and elm are almost as abundant. They may be gathered ei in the fall or spring, but unless they are very carefully heeled in protected over winter the better time is early spring. In collec forest seedlings only the small trees that have grown in the should be taken, as these are more likely to be young and vigo than those grown in the shade. The collector should never pul trees from the ground, but should dig them carefully with a sp preserving as much of the root as possible. As each tree is du should be placed in a barrel containing water until all are colle when they may be heeled in together, as described for stock purch from a nursery (p. 16). The pupils will be eager to enter into part of the work, and, under the direction of the teacher or sup tendent of planting, they can do it as well as anyone. It will pleasure to them, and the knowledge gained will be valuable.

Home-Grown Seedlings.—If wild seedlings can not be collected it is not convenient to buy the trees from a nursery, it will be n sary to grow them from the seed. This method has the advant of being economical and of supplying the stock exactly at the needed. It is an easy matter to grow forest seedlings, and to one likes trees it is a pleasure. The superintendent of planting sh arrange to have the seedlings grown by some reliable person, a will be helpful to have the school children assist in gathering planting the seeds. (See fig. 7.) If grown from seed, the trees usually need to remain in the nursery only one or two years. before time for planting they should be taken up and heeled i that they will be in readiness when wanted.

Trees from a Nursery.—The most common method of obtai forest trees in regions remote from the natural woodland is to chase them from a nursery. Nearly all nurseries grow trees ornamental planting, and a number in the prairie States offer s for forest planting. Where large quantities are handled, the are usually sold as seedlings when one or two years old, and quoted by the hundred or thousand, the price for ordinary k ranging from $2 to $7 per thousand. Ornamental trees are at the age of from three to five years, after having been transpla once or more. They are sold by the single tree, or in small qu ties, at prices ranging from 10 to 25 cents each.

As a rule there is little to be gained by planting large trees. If only a few are to be planted and the best of care can be given them, trees 8 or 10 feet high, or even larger, may be used, and are much less likely to be injured after planting; but if a number are required, smaller trees are better. Besides costing much less, they are not so bulky, and are therefore less expensive to ship, less difficult to plant, and are always transplanted with greater success than larger ones. Fig. 8 shows a good size. This tree is two years old and 36 inches high.

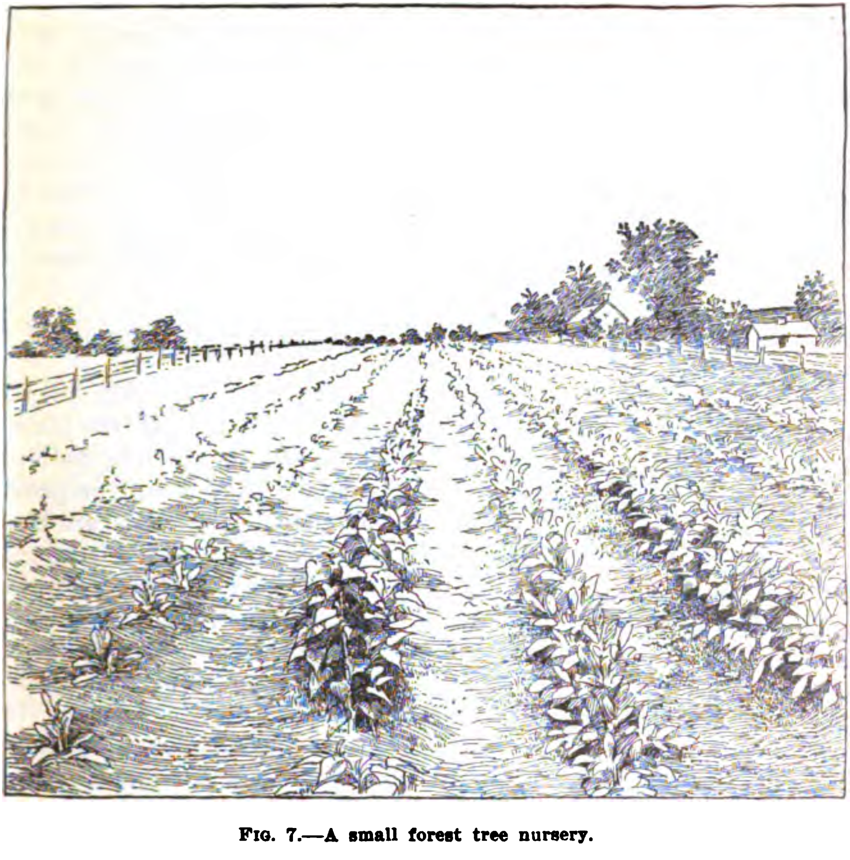

FIG. 7.—A small forest tree nursery.

The trees should be on hand as soon as the freezing is past in the spring. To insure delivery at the proper time, they should be ordered two or three months beforehand. It is usually best to order from a nursery in the same region, and, if possible, one which can ship over a single line of railroad. Every precaution should be taken to prevent delays in shipment and transit, and the receiver should be ready to care for the stock when it arrives.

As soon as the trees are received, they should be unpacked an pared for heeling in by placing the roots in a thin mixture ma stirring together earth and water. They should remain in this a trench is being dug, deep enough to bury the roots and abou of the tops. It should extend east and west, with its south sloping at an angle of about 30° with the surface of the ground this is placed a layer of trees, with their tops leaning south and roots and trunks covered and well p with fresh fine earth taken out on the side of the trench. In the trench formed on the north side of the first is placed a second layer, with the tops l over on the first and covered in the way. This operation is continued un the trees have been heeled in. They s be left in this condition until the ti planting.

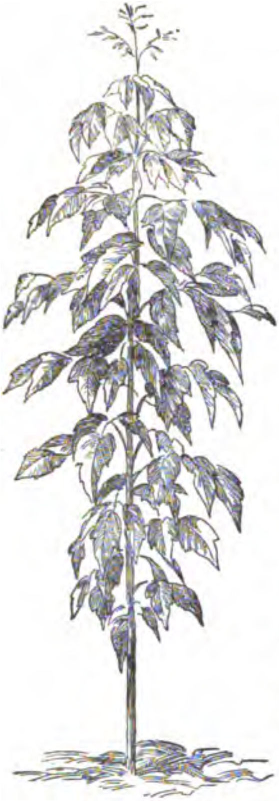

Fig. 8.—Box Elder seedling, two years old, 36 inches high, showing a good size for planting.

HOW TO PLANT THE TREES.

Preparation of the Soil.—Thorough p ration of the soil should precede the ing. Where blocks or belts are to be fo the ground should be plowed and pre as for a garden crop. Clay soils ar plowed the previous fall, in order th ground may weather over winter. Or soil subsoiling is beneficial, and should cede the planting by at least one s Just before planting time the ground s be pulverized with a roller or harrov the planting is to be done in rows, the g should be marked off lengthwise and wise and the trees set at the intersection is sometimes desirable to mark off the g only one way and run furrows the In arid regions the furrows may be dee into trenches, so that rain water which falls on the surrou ground may be drained to the tree. On the other hand, in r having a copious rainfall it will frequently be necessary to pla trees on a raised portion or mound of earth in order to keep th dry enough for them to thrive. The holes should be dug enough to contain all the roots fully spread out, and deep enou allow the tree to stand about 3 inches lower than it grew as a see

Time and Manner of Planting.—South of the thirty-seventh parallel, fall planting is safe and often advantageous. North of this, spring planting should be the rule, as fall-planted trees can scarcely develop sufficient roots to sustain themselves during the winter. The most successful nurserymen practice early planting for deciduous trees, beginning operations as soon as the ground ceases freezing. Evergreens are not planted until later; some even wait until the young growth is starting. If possible, planting should be done on a cool, cloudy day. Unless the day is very moist, the trees should be carried to the planting site in a barrel half filled with water, or a thin mixture of earth and water, and lifted out only as they are wanted. Even a minute's exposure to dry air will injure the delicate roots—the feeders of the tree.

The roots should be extended in their natural positions and carefully packed in fine loam soil. It is a good practice to work the soil about each root separately and pack it solid with the foot. As the hole is filled, the earth should be compacted above the roots and around the stem, in order to hold the tree firmly in place. The last 2 inches of soil should be very fine, and should lie perfectly loose. It will serve as a mulch to retain the moisture.

Trees should be planted neither in very wet nor in very dry soil. If the soil is wet, it is better to wait until it is drier. On the other hand, if good cultivation has been maintained the year previous to planting, the soil is not likely to be so dry that trees will not start. Besides insuring a supply of moisture, such cultivation puts the ground in good physical condition for planting.

With this treatment watering will scarcely ever be necessary. If it is, the holes may be dug a few days beforehand and filled with water. They should be refilled as the water soaks away until the soil is fully moistened. A thorough irrigation, when that is possible, is still better. As soon as the soil becomes somewhat dry the trees should be planted. While it is a common custom to water at the time of planting, those who do no watering are usually the most successful. Even in the semiarid regions some successful growers apply no water, but keep up an excellent system of cultivation, thereby retaining the soil moisture.

The spacing of the trees is not so important in school-ground planting as in forest plantations, yet it is worth consideration. The trees should not stand so near together as to produce long, slender poles; on the contrary, short, thick trunks are desirable, to support large tops and withstand heavy winds. From 8 to 12 feet apart will be suitable spacing distance. Where large blocks be planted the trees may be closer, but it is scarcely ever des to plant them closer than 6 by 6 feet.

WHY TREES DIE IN TRANSPLANTING.

To many persons it is a mystery why trees die after being planted. They do not die without cause, however, and whe begins to wither something is wrong. Oftentimes the result is be noticed until weeks after the injury; in other cases it is app in a few days. After the injury has been done it can be ove only by the subsequent growth of the tree. All the assistanc can be given is to make the surroundings of the tree favorab growth. The following are some of the causes of death among planted trees:

Loss of Roots.—The loss of the principal part of its root s when the tree is being taken up is a great shock to its vitality frequently causes its death. A very large part of the root m cut off, for usually the space surrounding the tree is filled fibrous rootlets, myriads of which can scarcely be detected wi naked eye. Almost all of these are lost, as well as many of the roots. Mr. D. C. Burson, of Topeka, Kans., last year dug u measured as much as he could of the root system of a vigorous Catalpa seedling that had grown from May till November. six-months-old seedling showed over 250 feet of root growth the methods in common use only a fifth, or perhaps as little as a of the root is taken up with the tree in transplanting. Suc throws the root out of balance with the top. If the top is not ened, or in some way protected, the leaves may evaporate moisture than the roots can provide, resulting in the death tree.

Exposure before Planting.—With proper subsequent treatment can endure the loss of many roots, but instead of the needed tion it often gets much unnecessary exposure to sun and dr This may be in digging, packing, shipping, unpacking, or any of the various handlings which it undergoes between its re from the ground and subsequent planting. On a warm day in the writer saw a bundle of trees in shipment across the pla Texas without the slightest covering. Before the destinatio reached the roots became withered and almost dry, having suff hundred times more exposure than the ordinary tree can stand out injury. Not many persons would be guilty of such gross n but the fact remains that exposure causes the death of more tr transplanting than any other single cause. Exposure can usua easily prevented, and no one who persists in neglectful practices can hope to be successful.

Failure to Plant Well.—The failure to pack the soil tightly about the roots is a common error in planting. It causes injury in two ways: It leaves the tree unstable, to be rocked to and fro or even blown down by the wind; it also prevents the first growth of rootlets from absorbing food. This they can not do unless good, fine soil is firmly packed around them. Clods will not pack snugly. Likewise manure or litter of any kind mixed with the soil may prevent firm packing. Anything that prevents the soil particles from coming into close contact with the roots is sure to be injurious. Another error is in shallow planting. This allows wind and water to lay bare the roots, and in a short time the tree dies. Crowding the roots into too small a hole is a similar difficulty. Such errors are more often due to lack of experience and skill than to haste. The unskillful planter will hardly plant well, however slowly he may go.

Wet Soil.—Trees are often injured by being planted in wet soil. Whether the excessive moisture is a permanent or a temporary condition is likely to make little difference in the results. If it is permanent the water prevents the air from reaching the roots, while if it is only temporary the trampling of the soil over them causes it to stick together so that on drying it becomes baked, leaving them impacted in a hard lump of earth which excludes the air. Excessive air currents in the soil are injurious by drying the roots, but a constant permeation of the soil by the air is necessary to supply oxygen. This process is precluded by either the saturation or the baking of the soil. Undrained pockets occur here and there even in well-drained fields, and are always difficult to deal with in tree growing.

Drying Out of the Soil.—Another cause of death is the drying out of the soil. Summer droughts are not unknown in any part of the country, and are very frequent in parts of the Mississippi Valley and on the Plains. Occasionally they are so intense and long continued that it is difficult to make recently transplanted trees survive, even when carefully planted and cultivated. In such a time, those which are poorly planted and cultivated are almost sure to die. Frequently, too, weeds and grass grow up in the plantation and draw off the moisture, thereby greatly diminishing the supply for the young trees.

On a school ground there is likelihood of the trees being injured by the trampling of the soil. The pupils will naturally wish to play among them, and unless they are restrained the soil will soon become compacted. It then dries out very quickly, and in time of drought the trees are sure to suffer, and may be killed.

CARE OF TREES AFTER PLANTING.

Cultivation.—Important as the process of planting is, one ca be certain that a tree planted with the greatest care will live an maturity. Much depends upon the after-treatment. In man of the country cultivation is absolutely essential, and nearly where a tree will thrive better and grow faster during its earl with cultivation than without it. The purposes of cultivat mainly to protect young trees from the encroachment of we grass, to keep the soil in good physical condition, and to ret moisture. Good cultivation is that which serves these purpos out injuring the trees. It does not necessarily include deep In fact, deep tillage may be positively injurious by breaking feeding roots, and is usually not necessary to loosen the soil few soils are too hard for tree roots to penetrate if moisture is ful. The best way to retain moisture is by frequently stirr soil to a depth of 2 or 3 inches. The longer cultivation is co the better will be the effect upon the trees. It should not any case until they are well established and prepared to thri out further attention.

Scattering or isolated trees can not usually be cultivated ex occasionally spading up the earth within a circle of a f around them. This is necessary in order to keep the grass an from crowding them and retarding their growth.

The difficulty of tilling a school-ground plantation will co ing the vacation period. That is the busy time of the yea crops must be tilled and harvests reaped. Unless the pe charge is very watchful the plantation is sure to suffer.

Increasing the Moisture Supply.—Although artificial wat not recommended, it is necessary to keep the soil of the pl moderately moist. Sometimes a great deal of moisture can b by conducting to the plantation the water that drains from a slopes. A small trench made to correspond with the conto of a hill or slope will often gather almost all the surface-d water. In the Northwest trees planted as snowbreaks a f from the north and west sides of the plantation will cause th of snow to form just outside of the plantation. The trees w be saved from breakage, and a helpful supply of moisture added at the edge of the plantation.

Pruning.—Within a few years after planting some pruning necessary to remove the broken and useless branches and cor tendency toward crookedness. Much pruning should be don the trees are young, because the wounds made then are small a quickly heal. Also very much less labor will be required t at this time than later, because the branches which can be r with a knife or pruning shears on a two-year-old tree will have to be removed with an ax or saw a few years later. The plantation should be pruned about every third year, but if careful attention is given to pruning when it is young, very little later work will be required. The best season is late fall or very early spring. Good pruning requires care and skill. The best work is done with pruning knife, pruning shears, and saw. The branches should be cut off close to the trunk, leaving no projecting stub or shoulder. The brush should be taken out of the plantation and burned as soon as dry.

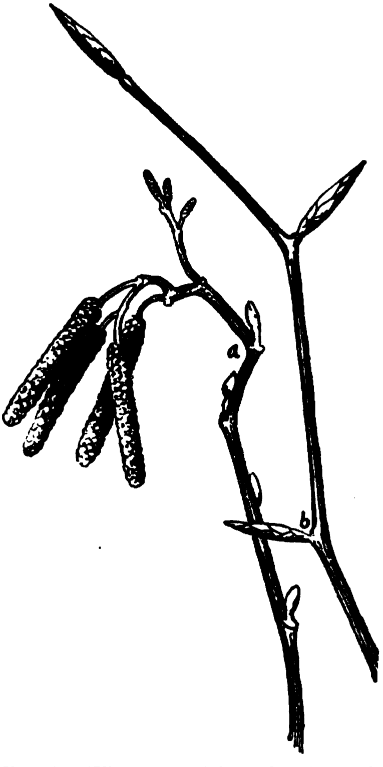

FIG. 9.—Winter condition of twigs and buds: *a*, Smooth Alder; *b*, Beech.

Protection of Trees from Injury.—The responsibility will devolve upon the teacher to inculcate a spirit of respect on the part of the pupils for the plantation. The best way to do this is to make them feel a responsibility for its success. If they feel a personal pride in it, there is little danger of their giving the trees rough usage by bending or breaking them.

In some rural districts where danger of injury from trespassing stock is not overcome by an ornamental hedge or by the grouping of shrubbery, as mentioned in connection with the planting, the grounds should be inclosed by a fence. A neat paling or a fence of woven wire will answer the purpose.

STUDIES FOR THE TEACHER AND SCHOOL.

A thrifty plantation of trees or a woodland lot presents a field for varied and important observation, which the teacher experienced in presenting topics of nature study will know how to appreciate. Nowhere can better illustrations be found of the operation of many important biological laws, and the lessons learned here are sure to be remembered, because, once grasped, other examples of the same phenomena are certain to be constantly presented to the awakened attention of the boy or girl.

Characteristics of Trees.—Naturally one of the first lessons in this forest work will be to study the different kinds of trees, and to learn the characteristics which separate them into groups; for exa the points of difference between conifers and broadleaf trees, bet oaks and maples, and even between one kind of maple and anoth

Prominent among the distinguishing characters of trees are twigs, buds, leaves, flowers, and seeds. Great variation wi found, variation not only in trees of different kinds but in the tree at different seasons. The summer and winter conditions of and buds of deciduous trees are so different that one can sca identify a tree in winter from a knowledge of its summer appear Fig. 9 shows the winter condition of twigs and buds of Sn Alder and Beech; fig. 10, the twig and leaves of Horse Che In studying seeds it is important to notice such points as how are borne, their structure, shape, size, time of ripening, and mea dissemination. Figs. 11 and 12 show the seeds and leaves of Elder, Silver Maple, and White Oak. Fig. 13 shows the late w condition of acorns after having begun to germinate the previous while fig. 14 shows condition after a few spring days have pass

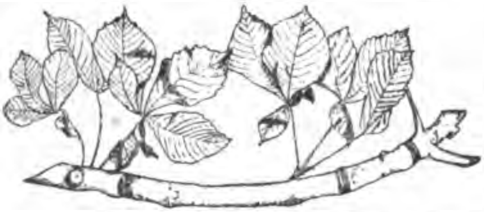

Fig. 10.—Twig of Horse Chestnut, showing leaves and annual growth.

Influence of Soil Trees.—The study of soil preferences of tr important, because fr we gain a knowledge c of the chief factors ir growth. For this stu is best, if possible, to go to the natural woods, for there will be the results of many years of struggle among numerous species no help from man to aid the growth of one tree or retard th another. Under such conditions, when one species establishes to the exclusion of all others, it may usually be inferred tha species is better adapted to the situation than any of its rivals. should be kept in mind as one notes the willows and alders thr in low, wet places, the Chestnut and White Oak upon gravelly r or the change from the broadleaf to the coniferous forest betwee base and summit of a high mountain. If the school is not n natural forest or a mountain, the slight forest growth along a st or even a plantation, will afford the teacher many opportuniti investigations of similar character.

Composition of Soils.—It is desirable that every teacher should something about soils. He should be able to distinguish a s sand, loam, marl, or clay, and know something of the formati each, and of its capacity to absorb and retain moisture and heat.

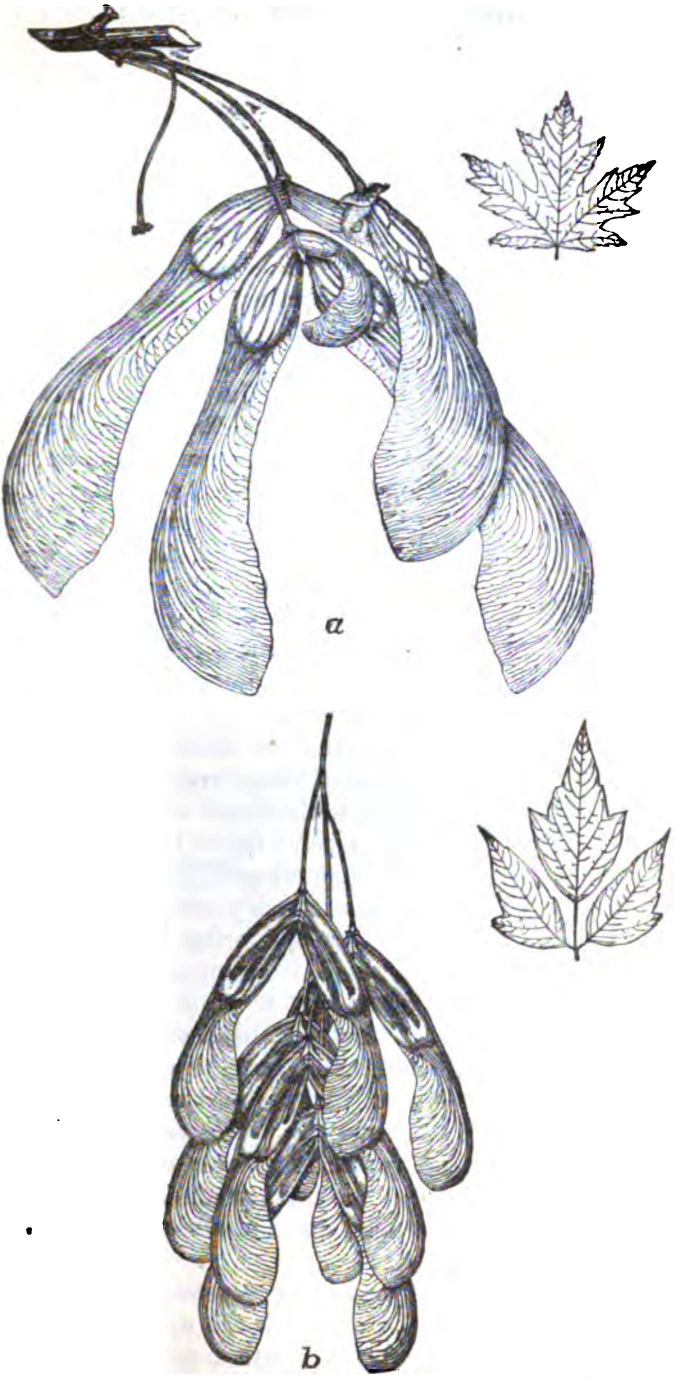

FIG. 11.—Seeds and leaves: *a*, Silver Maple, mature seed (natural size), mature leaf (one-fourth natural size); *b*, Box Elder, mature seed (natural size), mature leaf (one-fourth natural size).

only the surface soil, but also that part which lies hidden belo subsoil, should be examined, for both have great influence the growth of a tree. Most trees send their roots deep into the gr and if their course is retarded by a tenacious layer of clay or a permeable layer of stone, the tree will not attain its full growt development. Then, it will be found that one kind of tree thri sandy soil, and another kind on soil; that one flourishes on a sunn posure, while another does best shaded northern slope; here is a tre grows well only where the soil is porous, and fertile; there is one that satisfied on the poorest gravelly

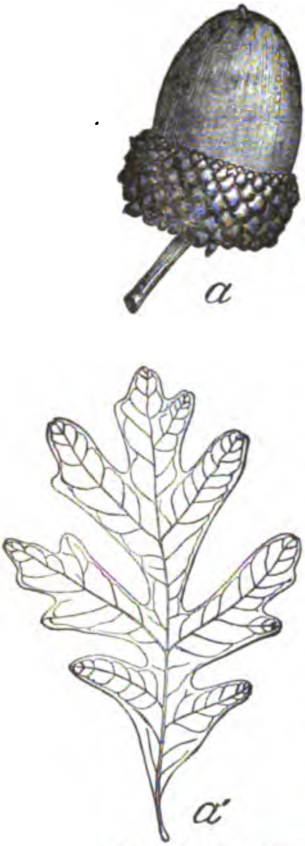

FIG. 12.—White Oak: *a*, mature acorn (natural size); *a'*, mature leaf (one-third natural size).

Influence of Trees Upon Soil.— the soil has a great influence upon it is also true that trees have a gre fluence upon the soil. Selecting a where large trees stand closely cro together, one may rake aside the layer of leaves and see that it has ke soil moist by preventing evaporatio may notice, also, that the lower lea the layer are wet and moldy. The beginning to decay. Among the pieces of twigs, cones, and husks of All are blackened and appear to be ing to soil. Below this layer is anot the same material, but still more lik and in it is a dense tangle of living lets of neighboring trees and shrub this soil is examined closely, it w found that it is not like the soil of cultivated fields, composed of small bles and grains of sand, but is ma mostly of decayed leaves, wood, and Deeper down, this vegetable mold be less, and granular particles appear in greater abundance, but i not be possible to see any but the most gradual change from the other. On digging far down into the subsoil one constantl through old decaying roots.

Thus trees are constantly returning vegetable matter to th from which they grow. They add to it the mold which gives dark color, its power to absorb and retain moisture and heat, a a large degree, its porosity and fertility. A dense cover of trees will in time transform the poorest soil into a fertile one.

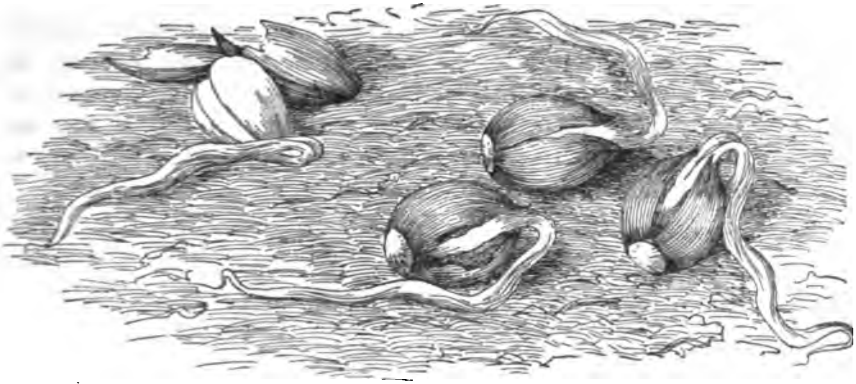

FIG. 13.—Acorns collected beneath a cover of leaves in February. Germination had begun the previous fall.

Influence of Trees upon One Another.—Trees are often dependent on one another in their germination and growth. In fig. 15 young White Pine seedlings are coming up under the sheltering branches of a Chestnut. It gives them an increased supply of moisture and partial shade, and nowhere else near by have they come up in such abundance.

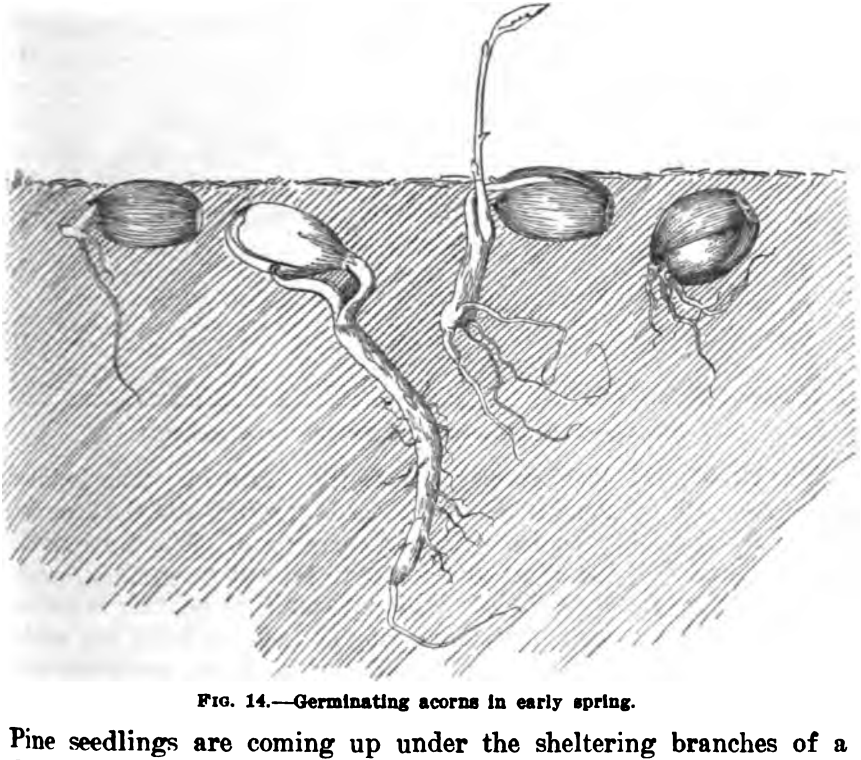

FIG. 14.—Germinating acorns in early spring.

Such is frequently the case in the forest. The tender seedling
the protection afforded by the older trees. There is, howeve
phase of this interesting matter. Within a few years t
seedlings reach the stage where they require the sunshine fr
they needed protection when young. Then the same ov
trees that sheltered them in their infancy become a menace
In many cases they grow a few years and die. Now and
finds a gap among the tree tops and grows up to occupy it,
itself a dominant tree in the forest.

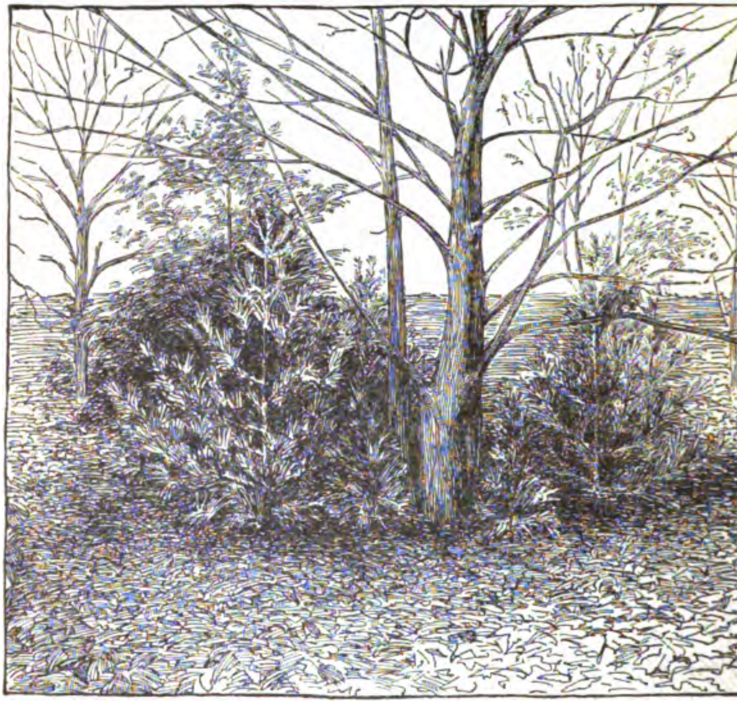

FIG. 15.—White Pine under the protection of Chestnut.

The density of trees greatly affects their growth. The
tree grows with a short trunk and spreading top, while the
one produces a long, slender trunk and narrow top. The dif
form is caused by the effort of the tree to present its great
of leaf surface to the sunlight. Where it stands alone, this
plished by the top assuming a spreading or rounded form, b
it is crowded by others and shaded on all sides, it can reach
light only by pushing upward and overtopping its rivals
there is a continual struggle among crowded young trees
upward growth, and as they grow their lower branches bec
and more densely shaded until they die. Decay follows,

they drop off, leaving the trunk clear of branches. Fig. 16 shows the extreme form of an isolated tree, while fig. 17 shows the slender upright growth of a tree grown in a forest. Each form has its value and use—the spreading tree for shade and ornament, and the straight, unbranched tree for lumber.

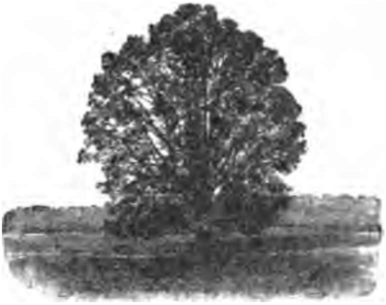

Fig. 16.—Oak grown in the open.

Books and Trees.—For the most part, a knowledge of trees can best be obtained from the trees themselves. There are some things, however, that can be more easily and rapidly learned from books: First, we can learn best from books the important things to look for, or what to study; second, many inaccessible kinds must be studied from books or not at all; third, there are some things about trees that can be more readily learned from books than from experiment, such as how to handle, transplant, and cultivate them.

Knowledge will be gained much more quickly, and will be more comprehensive and much less likely to include erroneous notions, if obtained not alone from the natural objects, but in part from the best works on the subject. So, in silvicultural studies, that teaching will be most valuable that leads the pupil into both original investigation and the study of books.

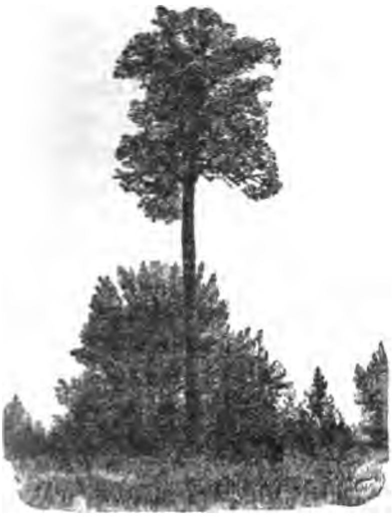

Fig. 17.—Maple grown in the forest.

FACTS ABOUT TREES.

Life Processes.—Trees are living things with vital functions and parts. They have systems of digestion, assimilation, and respiration, with specialized organs for carrying on the various processes, much the same as animals. In correspondence with most of the vegetable kingdom, their leaves have the power under the action of sunlight to absorb carbonic-acid gas from the air, to break it up, and, with the carbon obtained and water, to form starch. The oxygen is returned to the air unused. The water comes directly from the soil through the roots and stems, and carries in solution mineral compounds which enter into combination with the starch, formin more complex compounds such as the tree can readily utilize. are drawn away to the branches, stem, and roots, there orga into living substance, and made a part of the tissues of the tree.

To carry up the supply of minerals from the roots to the l much more water is required than the tree can utilize in the f tion of starch. The excess passes off as vapor through the po the leaves into the atmosphere, by a process of transpiration.

A tree breathes for the same purpose as an animal. It tal oxygen and throws off carbonic-acid gas. The process is no tered in a special organ, but goes on over all parts of the l branches, and roots. In the leaves the breathing goes on throug pores; in parts of the tree covered by bark it goes on through th ticels—the small, light-colored, raised spots plainly seen o young branches of nearly all trees. Breathing is an entirely sep process from that by which carbonic-acid gas is taken in throug leaves and oxygen liberated. It goes on both day and night a all seasons of the year, though more rapidly in summer th winter.

Life History.—A tree has a definite life history as an orga with periods of growth, maturity, and decline, and characte development in matters of form, structure, and size. There is m difference in the rate of growth of different trees, and even of th tree at different ages. Most of the pines grow very slowly for th ten or twelve years, but much more rapidly after that. Other such as the Tulip-tree, grow rapidly for forty or fifty years, an more slowly. Still others, such as the oaks, have a very regula of increase throughout the growing period. Great variation ex the age at which trees become mature. While some reach ma at the age of fifty or sixty years, many of the most valuable co cial trees become mature at from one hundred and fifty t hundred years. The Redwood of California often is not n before the age of a thousand years. A tree will continue to some growth through its maturity and decline, though c its maturity its height growth has almost ceased and its dia growth is slow. Decline begins when the destructive forces c the growth forces.

Given the same climatic and soil conditions, one tree will a one form, another a form very different. The beech will f round, much-branched top, the Red Cedar a slender tree with a c stem. The oak will reach majestic proportions, the dogwoo become nothing more than a shrub. The hickory will form l elastic wood, the birch that which is light and brittle. The pin yield resin and turpentine; the oak, tannin; the maple, sugar. Thus each tree preserves perfectly its identity in external form and internal structure and composition.

Reproduction.—A tree reproduces either by seeds or buds. In nature, reproduction by seeds is more common, although reproduction by buds is quite as regular as by seeds in some species. The tendency of the locust to sprout from the roots and of oaks to renew growth from the stump are examples of bud reproduction. The forester in handling woodlands depends upon both methods. Such trees as reproduce only by seeds he keeps by leaving seed trees distributed over the land when the crop of timber is cut. Those that reproduce from buds renew their growth from the stumps of the cut trees. Not only does bud reproduction take place when the buds are attached to the parent tree, but also when they are separated from it. A tree may be divided into many parts, each part becoming a new individual. This gives rise to propagation by cuttings, grafts, and buds. Many forest trees can be propagated by cuttings, and nearly all can be grafted and budded.

Food.—In harmony with all other living things, trees require food. Their food is composed of the carbon obtained from the air and the water and mineral compounds obtained from the soil. Carbon, oxygen, hydrogen, nitrogen, magnesium, calcium, iron, sulphur, phosphorus, potassium, and chlorine are called essential elements because, with trees as with all other plants, their presence is necessary to thrift. Other elements are absorbed when present in the soil in soluble form, but their absence causes the tree no loss in vigor. The elements are not absorbed separately and alone, for they rarely exist in that condition, but are blended together with one another into compounds. Thus, in water the plant obtains both hydrogen and oxygen. Potassium, nitrogen, and oxygen are often united in the form of potassium nitrate, a valuable plant food.

Solubility of Plant Food.—Trees are able to absorb the mineral compounds only as they are in solution in the water taken up by the roots. Many compounds of the soil which contain valuable food elements are insoluble in soil water, and therefore unavailable. Thus, while potassium is an essential element, it may be in such combinations with aluminum, silicon, and other elements as to be insoluble and useless. Chemical changes are slowly going on in the soil by which insoluble compounds are converted into soluble compounds. Cultivation and fertilization hasten such changes, and to do this is one of their chief purposes.

Quantity of Food.—When the food of a tree is in available form, the greater the supply the more rapid its growth. Fertile soil has an

abundance of food materials, with the result that a tree situat
it grows rapidly. Sterile soil is deficient in food materials
quently a tree situated upon it grows slowly. The same
together with the conservation of moisture, explains the diffe
growth between cultivated and uncultivated trees upon the sa
of soil. The cultivated tree, with its larger store of food and
and its protection from the competition of weeds and grass,
outstrips its less fortunate neighbor.

Essentials to Growth.—A tree can grow only when supplied
light, moisture, and heat.

Air is necessary because it supplies the oxygen used in the
of respiration, and holds the carbonic-acid gas used by the l
forming starch.

Light is essential that a tree may carry on its processes of di
So sensitive is a tree to light that it will change its form and
growth to obtain the quantity it needs. In a thickly plante
the trees on the edge will bend outward, while those in the
will grow tall and slender, the growth of each hastening in th
tion of greatest light. In the absence of light a tree ceases t
esses of digestion by which its food is prepared for use, a
short time even loses the organs concerned in its preparation;
the chlorophyl bodies which give the green color to the leaves.

The necessity of moisture is a matter of common obse
Water is one of the chief agents in the nutrition of a
already mentioned, entering into its food in large quantities a
ing as a carrier of food materials from the roots to the leaves.
the diminution of its water supply a tree lessens its growth an
part or all of its leaves in its endeavor to survive. If the
continues to decrease it finally withers and dies. Yet in th
mands for water trees differ vastly. Some can thrive only wi
roots in constantly saturated soil—as, for example, the Ta
of the Northern and the Bald Cypress of the Southern States.
is every degree of variation between trees of this character an
of the desert, where the annual rainfall is limited to a few inc

Every tree is adapted to a certain range of temperature, dep
upon its power to endure heat and cold. Some, like the pal
thrive only with a constantly high temperature; others, like
the oaks, are adapted to alternating seasons of heat and co
others, as some of the birches and poplars, can endure extre
continued cold, with only a short period each year warm eno
growth. Such adaptations account for the distribution of
over nearly the whole of the earth's surface not constantly cov
ice, and also largely for the character of the forest in different

noisture principally determine forest distribution

—Local variations in heat, light, and moisture rowth. It is not uncommon to find very different h side of a mountain from that on the south side, ide is cooler, moister, and not so light as the south trees well adapted to the conditions on the north here, while on the south side they will make infe- appear at all. West of the Mississippi River the margins of streams far beyond the point where it , principally because the moisture and atmospheric e streams are more favorable to growth.

ip.—In almost every region certain kinds of trees . This is due to a similarity of preferences in t, moisture, and light. Two trees adapted to the ill thrive best in the same situation. The White alnut are good examples. Having similar prefer- most identical ranges and are very generally asso- also another reason why trees accompany one ay so influence its surroundings as to make them r tree, where otherwise they would be unfavorable. uch influence, the Chestnut on sterile, sandy plains w England forms a much-branched tree, which and keeps it moist and cool. Such conditions are ermination of the White Pine in that region; con- nd coming up abundantly beneath the Chestnut, tly on the open, unprotected ground.

in Surroundings.—A change in the surroundings of ifies its habit of growth. If the change is toward rroundings the result is seen in increased vigor, d size; if toward unfavorable surroundings, the e. The stately Tulip-tree of the central Eastern a mere shrub in Florida. The reason is that there ge of adaptation. The White Elm, which grows like form in New England, in the semiarid parts of oma is low and spreading like an apple tree. Nor ariable character. On the western elm the leaves er, smaller, thicker, and much rougher than on the In other parts of the tree there are differences of ugh they are not so noticeable as those in the form e variations have resulted from the differences in nditions to which the tree has been subjected.

Gradual Change.—The difference in form between two tree
same kind in different localities has come about through
divergence of characteristics. To a certain degree changes
kind can be brought about in practice. When a gradual c
made in the surroundings of a tree a corresponding chan
place in the tree itself. Thus if stock of the New Englan
slowly moved westward through many generations, it will g
change in form and other characteristics to be like the weste
and it must be assumed that this change is necessary to ena
live under its new conditions.

Sudden Changes.—Sudden changes in the surroundings of a
quently cause its death, because it can not quickly change
meet the requirements of its new conditions. The New Engl
moved at once to the semiarid West is likely to die, because
adapted to the conditions of soil, light, heat, and moisture
region. In the prairie marshes of northern Indiana there a
sional knolls which once supported thrifty oaks of moistur
kinds. Now that the marshes have been drained the drying
the soil has caused the oaks to die. The change was too
Suddenness and intensity of change often account for the fa
trees to thrive when moved away from the region to which th
adapted. This is also why eastern trees so often die when m
the West. This is why nursery stock grown near by can
safely planted than that grown in a distant region. It is a
matter and should be generally understood.

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UNITED STATES DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN

WASHINGTON, D. C. 702 JANUARY 17, 1916

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UNIVERSITY OF CALIFORNIA

Contribution from the Bureau of Biological Survey, Henry W. Henshaw, Chief.

COTTONTAIL RABBITS IN RELATION TO TREES AND FARM CROPS.

By D. E. LANTZ, *Assistant Biologist.*

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INTRODUCTION.

Among the serious pests in orchards and tree plantations are the several native species of rabbits. These animals do considerable damage to garden truck and other farm crops also, especially on lands recently opened to cultivation. North American rabbits belong to two general classes easily distinguished by their size and habits.

The larger forms[1] include the arctic and varying hares, or snowshoe rabbits, and the jack rabbits, and are found throughout nearly all of Alaska and Canada and in all the States west of the Mississippi except Arkansas and Louisiana. East of the Mississippi they inhabit the northern parts of Minnesota, Wisconsin, and Michigan, most of New York and New England, and southward in the Appalachian Mountains, parts of Pennsylvania, Maryland, and Virginia.

The smaller forms,[2] generally called "cottontail rabbits," occur in every State, but are absent from the greater part of Maine, the

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[1] Genus *Lepus*.
[2] Genus *Sylvilagus*.

NOTE.—This bulletin discusses the distribution and habits of cottontail rabbits and methods of controlling their ravages on trees and cultivated crops by means of trapping, poisoning, and supplying safeguards. For general distribution.

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northern parts of New Hampshire, Vermont, New York, I Wisconsin, and Minnesota, and from the western parts of Wa and Oregon. In recent years they have extended their ran ward in the New England States, New York, and portions of and have invaded and occupied a considerable part of the of Ontario. In habits they differ materially from the la bits. They live in copses and thickets more than in open fie young are born blind, naked, and helpless, while those of t rabbits have the eyes open, are partially furred, and act born.

Rabbits of both genera, however, feed exclusively on ve and are at times harmful to crops and especially to trees. of their size and great abundance in parts of their range, bits are by far the most destructive, but, except in a few pla they have been introduced, none are found east of the Mi Epizootics (diseases which attack many animals at the sa are an effectual natural check, and after such attack occ rabbits are usually so reduced in numbers that they are no some again for several years.

Traps and other devices that are effective with cottonta do not always succeed with jack rabbits. The recommendat tained in this bulletin will, therefore, apply only to cotto bits, but they may suggest methods that, with modification used against the larger forms.

HABITS OF COTTONTAIL RABBITS.

Cottontail rabbits (fig. 1) are so well known that littl said of their habits. They breed several times each year d warmer months, the litters averaging five or six young. is usually placed in a hollow or depression of the ground, open fields or meadows. It is composed of dead grass and lined with fur which the female pulls from her own body. rabbit takes no part in caring for the young, and the fema them as soon as they are able to leave the nest. These anim so rapidly that in spite of many natural enemies, and of that they are hunted for human food, they often become n enough to inflict serious losses on farmers and fruit growers parts of the United States (fig. 2).

Cottontail rabbits eat all sorts of herbage—leaves, stems and seeds of herbaceous plants and grasses—and leaves, bu and fruits of woody plants or trees. They usually prefer succulent foods, as young shoots, tender garden vegetable alfalfa, and fallen ripe fruits; but they exhibit also a re

in their selection of certain varieties of cultivated
r neglect of others of the same species. Prof. C. V.
ıt in Oregon rabbits ate Arabian alfalfa down to
e they did little or no damage to other varieties
ıding plats. Prof. C. A. Mooers, of the Tennessee
periment Station, reports similar observations in
aste for soy beans, stating that they greatly relish
low variety and that it is practically the only one
their depredations. When favorite foods are absent
vhatever is available. It is during summer droughts

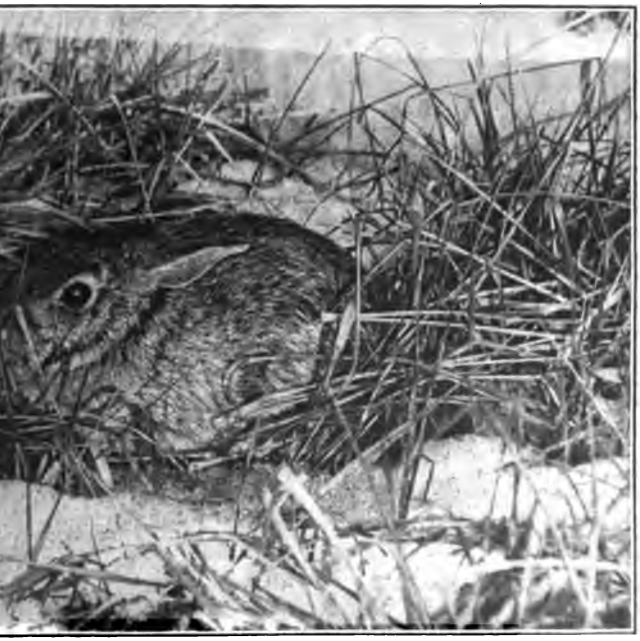

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FIG. 1.—Cottontail rabbit in its "form."

ws cut off ordinary supplies that the animals attack
ng trees or shrubs.

PROTECTION OF RABBITS.

its are valuable for food and afford excellent sport
many States, especially east of the Mississippi
protected as game. In fruit-growing and truck-
farmers regard them with disfavor, and there is
lry between sportsmen and farmers to have their
reflected in game laws. The interests of the two
iously differ, however, for when rabbits are closely

hunted losses from their depredations are usually reduced to
mum. Still there is danger that in years favorable for th
crease the animals may inflict serious injury to trees during
winters.

Rabbits are protected (1915) by close seasons in States and
inces as shown in Table I. Twenty-eight States, Alaska, a
Canadian Provinces not mentioned in the table do not prote
bits of any kind. In the District of Columbia all shooting

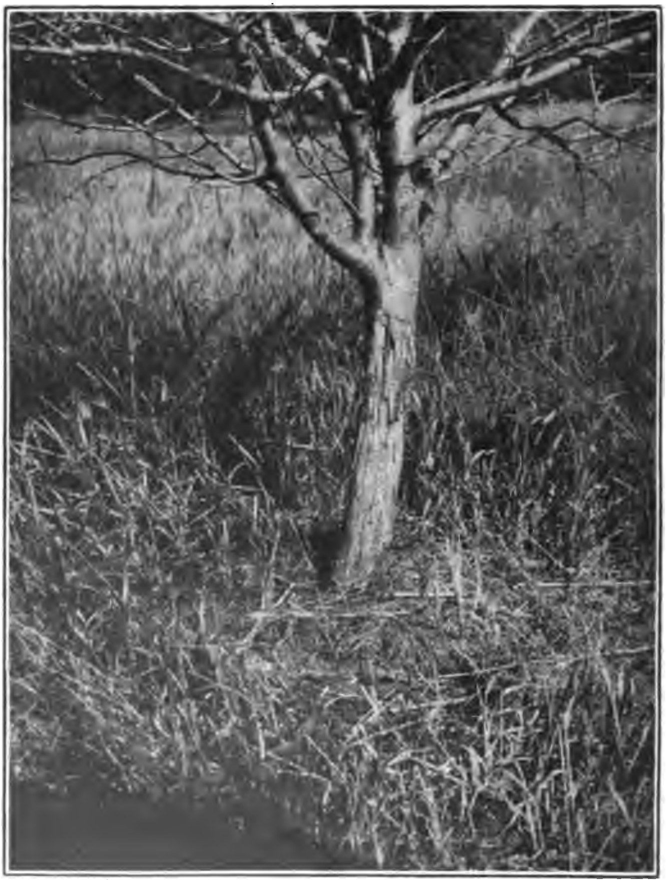

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FIG. 2.—Apple tree killed by rabbits.

hibited except on certain river marshes. In Kentucky rabbi
be taken with dog, trap, or snare at any time, and the close seas
shooting is evidently solely for the purpose of keeping gunn
of fields and woods during the two months immediately pre
the open season for quails. In Wisconsin 46 counties, mostly
southern half of the State, have no close season for rabbits. I
fornia only cottontails, or bush rabbits, are protected.

State or Province.	Beginning of open season.	Beginning of close season.	Length of open season.
			Months.
	Oct. 1	Apr. 1	6
hire.	...do.....	Mar. 1	5
	Sept. 15	...do.....	5½
ts.	Oct. 12	...do.....	4⅗
d.	Nov. 1	Jan. 1	2
	Oct. 8	...do.....	2¾
	Oct. 1	Feb. 1	4
land.	Nov. 1	Jan. 1	2
	Nov. 10	Dec. 16	1⅕
ia.	Nov. 1	Dec. 1	1
	Nov. 15	Jan. 1	1½
	Nov. 10	Dec. 25	1½
olumbia.	Nov. 1	Feb. 1	3
	...do.....	...do.....	3
	Nov. 15	Sept. 15	10
	...do.....	Dec. 5	⅔
	Apr. 1	Jan. 10	9⅓
	Aug. 31	Feb. 1	5 1/30
	Oct. 1	Mar. 2	5 1/30
es.	Sept. 10	Feb. 1	4⅔
ies.	Oct. 10	...do....	3⅔
ies	Nov. 1	Jan. 1	2
	Oct. 1	Mar. 1	5
	July 31	Feb. 1	6 1/30
umbia.	Sept. 1	Jan. 1	4
	Oct. 1	Dec. 16	2½
	Oct. 15	Feb. 1	3½
	...do.....	Mar. 1	4½
and.	Sept. 20	Jan. 1	3⅓
ard Island.	Nov. 1	Feb. 1	3
a.	Oct. 1	Mar. 1	5

out half the States that have a close season for rabbits the
rmit farmers and fruit growers to destroy the animals to pro-
ps or trees. Such provision might well be incorporated in
ws of all States. For lack of it farmers have sometimes suf-
evere losses, and not a few have been compelled to pay fines
ing to protect their property from rabbits. In States that
rabbits it is well for the farmer to be acquainted with the
ws and in case of doubt to have a clear understanding with
d State game wardens before undertaking to destroy rabbits.

MEANS OF REPRESSING RABBITS.

NATURAL ENEMIES.

ng the agencies that help to keep down the numbers of rabbits
more effective than carnivorous birds and mammals. These
large hawks and owls, eagles, coyotes, wildcats, foxes, minks,
, dogs, and cats. Eagles, the larger species of hawks, and all
ge and medium-sized owls make rabbits a great part of their
From the standpoint of the farmer and fruit grower these
nd certain carnivorous mammals are far more beneficial than
l. On the other hand, poultry growers and sportsmen regard
enemies to be destroyed whenever possible. In the absence

of such natural enemies, rabbits, as well as rats and mice, often bec a menace to valuable crops. Indiscriminate slaughter of carnivo birds and mammals should be suppressed whenever rodent pests to be controlled.

HUNTING.

Hunting has been the most important factor in keeping d the numbers of rabbits in America. In some parts of the country animals have been so reduced in numbers by shooting that sports have invoked legislation to prevent their extermination. Shootin undoubtedly the best method for hunting this animal. Ferretin often impracticable, since our native rabbits do not habitually row; besides, the use of ferrets is forbidden by law in many St that protect the rabbit. Coursing with greyhounds is popular in West, where the swifter jack rabbits are abundant. Cottontails often chased with foxhounds, but the beagle is rapidly taking p dence as a favorite for hunting these animals, the gun being use secure the game.

Where the country is sufficiently open for the purpose, the or ized hunt, in which everyone who owns a gun is supposed to part, is a good means of reducing the number of rabbits. T organized hunts are popular in the West, where they are also va in the case of jack rabbits, by what is known as the "rabbit dri A large territory is surrounded by men and the animals are dr into a corral built of wire netting. While a few cottontails are s times included in the catch, these usually find refuge in open burr or under cover of rocks or brush, so that this method is hardly ap cable to them.

TRAPPING.

Rabbits are easily trapped or snared, and while these method taking them are slow, they are always feasible when cotton infest woodlot, orchard, nursery, field, or garden. Many are caugh old-fashioned box traps set with a figure-4 trigger with cord atta to hold up the box lid.

An improvement on this familiar trap, widely used in the Mi West, and often called the Wellhouse[1] trap, is a box 21 inches and about 6 inches high and 4 inches wide (inside measureme made of 6-inch fence boards, preferably old ones. The box is cl at the rear and has a wire door in front which swings inward f the top, a cleat at the bottom preventing its opening outward. trap is set and the wire door kept open by a wire trigger-rod hel place by two staples in the top of the box. The trigger-rod is downward into a loop or figure 8 near the rear of the trap. As trap and crowds into the back part it presses against the trigger-rod backward and is imprisoned as the ased and falls. Bait may be used but is unnecessary, frequently take refuge in dark places from ene- nt weather.

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[1] After the late Mr. Fred Wellhouse, of Topeka, Kans.

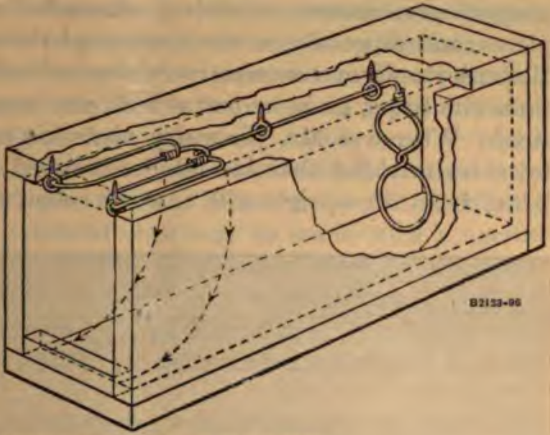
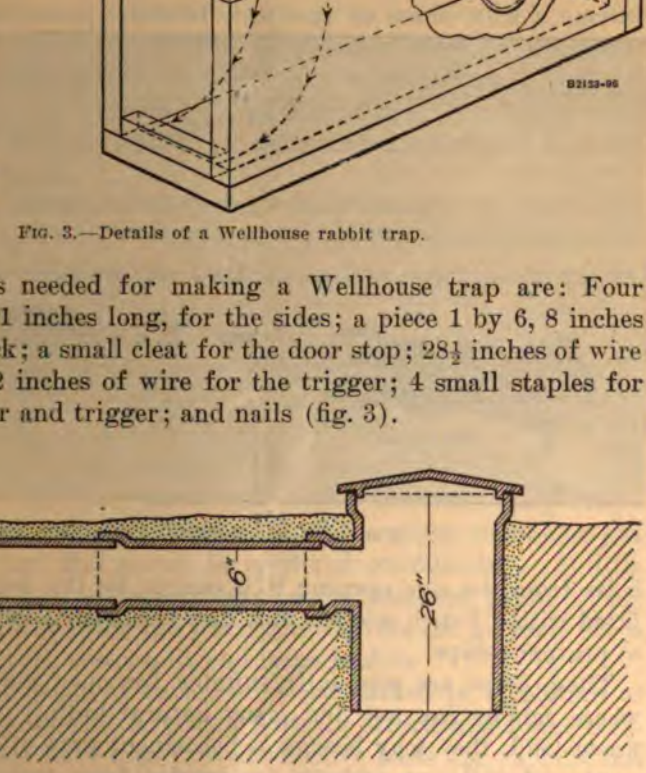


FIG. 3.—Details of a Wellhouse rabbit trap.

needed for making a Wellhouse trap are: Four 1 inches long, for the sides; a piece 1 by 6, 8 inches k; a small cleat for the door stop; 28½ inches of wire inches of wire for the trigger; 4 small staples for r and trigger; and nails (fig. 3).



—Cross section of a Walmsley tile trap for rabbits.

lmsley recently sent to the department photographs of a permanent rabbit trap made of sewer tile and ther farms in Kansas (fig. 4). A 12 by 6 inch "tee" long end downward and buried so that the 6-inch the surface of the ground. Two lengths of 6-inch en connected horizontally with the opening. Soil is placed over the joints to exclude light. The upright tile be fitted with a tight removable cover—Mr. Walmsley harrow disks for the purpose. The projecting end of the is surrounded with rocks, brush, or wood, so as to make the h inviting to rabbits (fig. 5), and that they may appropriate the place of concealment and shelter. A number of these traps in places, and especially in the vicinity of the orchard, have Walmsley's farm comparatively free of rabbits. Rabbits these tile traps, go in or out at will, and may be captured sired. Whenever Mr. Walmsley visits his traps he is acco by a trained dog that locates the trapped animals. The lifted from the upright tile and the rabbit captured by ha

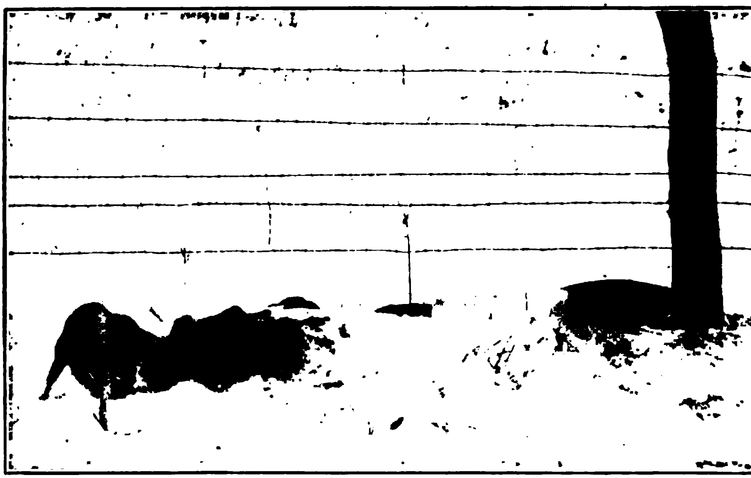


FIG. 5.—A Walmsley tile trap in use.

bolts from the side opening it is caught by the dog. A sh fitted with a 5-inch wooden disk may be inserted in the side to prevent escape.

These traps are especially suitable for open lands and where rabbits can not find many natural hiding places. waste land, they may become a permanent part of the far ment and will cost nothing for repairs from year to year. first cost may be greatly reduced by use of second-grade broken tiles. If one wishes to poison rabbits, the baits placed inside these traps and domestic animals or birds wil endangered. The Walmsley trap also furnishes an excellen of obtaining rabbits for the table or even for market without ing them by shooting.

for killing rabbits has been used in the West with consid-
ccess. Only in exceptional cases, however, is its use advis-
tates that protect rabbits. The most favorable season for
ison is in winter or after a long drought in summer has
een food scarce. In some localities summer poisoning is
l with by crickets or grasshoppers consuming the bait.

llowing method is adapted for general use: Insert crystals
nine or powdered strychnine in pieces of apple or melon
place these baits at intervals along rabbit runs or paths.
re to put the poisoned baits where children and do-
nimals can not get them. Where no well-defined runs
le in orchards, artificial ones may be made with a narrow
scraper. Along such runs or the dead furrows of plowed
bits habitually travel. Baits may be placed on the ground
d on short sticks along the path, and should be looked after
. **Any baits left after poisoning operations are finished**
e destroyed.

isoning rabbits in winter or during droughts the following
is recommended: Good oats, 12 quarts; powdered strych-
unce; laundry starch, 1 tablespoonful; soda (bicarbonate),
saccharine, ⅛ ounce; water, 1 quart. Mix the starch with
cold water. Pour this into 1½ pints of boiling water and
the boiling for a minute or two until the starch is clear.
dry strychnine and soda in a small pan and sift it over the
h, stirring thoroughly to form a smooth paste. Add the
e and stir again. Pour the mixture over the oats in a metal
ng until all the grain is wet. Allow the oats to dry before
ing. Not over a tablespoonful of the grain should be put
le bait and this should be scattered considerably. A little
ay will help attract rabbits to the poisoned grain. This
recommended for use when snow covers the ground. It is
against both cottontails and large rabbits.

ripened heads of barley or wheat soaked in a solution of
e and saccharine or coated with the starch-strychnine solu-
described have also proved effective baits for rabbits, but
re must be exercised in using them, as **they are likely to**
by live stock.

tail rabbits may be poisoned in winter by baiting them with
from apple trees and dipped in or thinly coated with the
rychnine poison. These twigs are scattered along rabbit
l are effective against both meadow mice and rabbits. They
langerous to domestic animals than grain baits.

BACTERIAL DISEASES.

The fact that when rabbits become excessively abundant locality epizootic diseases often destroy them in large numl led many people to expect that a micro-organism would b which would afford a ready means of rabbit control. The Bi Survey receives many applications for such bacterial prepa In reply to all of them it has been necessary to state that thu attempts to spread contagious disease artificially among wild have failed to give practical results.

PROTECTION OF CROPS FROM RABBITS.

Complete extermination of rabbits in any part of the States is not desirable, even if possible. They should be rec numbers only sufficiently to secure comparative safety to cr before active wholesale destruction of the animals is attemp possibility of crop protection by other means should be c considered. In many cases one of these means would prol the more economical method.

RABBIT-PROOF FENCES.

When rabbits are abundant and the area to be protected is great, a rabbit-proof fence may profitably be used. Wo netting is recommended for this purpose. This material is in use, not only against the rabbit pests of Australia and Eur in our own country against both large and small rabbits. species burrow less than the European rabbit the requirem rabbit proofing a fence here are not so great. Even the cot when driven by hunger, will dig under a fence, but this prevented either by use of wire with close barbs in contact ground or by plowing a furrow against the lower edge. A of galvanized wire with 1½-inch mesh and 2½ to 3 feet high i cient barrier against cottontails. Where snow is infrequent gardeners and nurserymen use a 2-foot fence, but in the No prefer to use a netting 3½ feet wide, and to turn from 4 to of the lower edge flat and cover it with soil. Netting r No. 20 wire costs from 25 to 35 cents a rod. Heavier netting increases the cost, but adds to the durability of the fence. lumber is cheap, a picket fence or one made of laths and practicable. When deep snows fall and drifts form, fences protection to crops against rabbits.

TREE PROTECTION.

WASHES.

Many devices for protecting trees from rabbits have been mended, the majority of which are paints, smears, or wash posed to be distasteful to the animals. Many are not su

ford protection for an entire winter, and most of
ing are injurious to trees. Coal tar, pine tar, tarred
under certain conditions, are dangerous to young
acid and other volatile substances afford only tem-
, and must be renewed too often to warrant their
ances, like commercial aloes and quassia, are useless

mising simple washes for protecting large trees
those containing lime mixed with sulphur or cop-
combinations. Lime alone is not sufficiently per-
ly where much rain falls. When mixed with
s it has a deep green color and sticks much better.
wash commonly used to destroy San Jose scale in
proved successful as a rabbit repellent, but its lack
ies often makes it fail. The defects may be partly
ing salt, soap, or a cheap glue with the lime and
wash is still hot.

sh of starch and glycerin, tried during the winter
ho by a field agent of the Biological Survey, gave
in protecting young orchards from jack rabbits,
bly be equally effective where cottontails are con-
h is prepared as follows:

ce of strychnine (sulphate) in 3 quarts of boiling
½ pound of laundry starch in 1 pint of cold water.
nto the vessel containing the strychnine and boil the
me until it is clear, adding 6 ounces of glycerin and
ly. When it is cool enough apply with a paint
trunks.

d starch adhere well and form a thin coating to the
ttacking the trees will be quickly killed. In the
ts none of the trees were damaged badly enough
owth and all the rabbits in the orchards were de-
ethod is well worth trying; but **care should be**
danger domestic animals.

MECHANICAL CONTRIVANCES.

t mechanical contrivances for protecting trees from
ders of woven wire netting. Poultry netting of
de of No. 20 galvanized wire, will answer every
lls 18 inches wide are used for cottontails, and the
to 1-foot lengths. One of the sections is rolled into
about the trunk of each tree and fastened at several
g and twisting the projecting ends of wire. No
s needed, but stakes or spreaders may be used to
rom pressing the wire against the bark and doing

injury through the meshes. These guards should be left or
trunks, and will last as long as the trees require protection. The
of material is less than 2 cents for each tree. These protectors
vary in size to suit the requirements of any particular localit
kind of tree. They may be adapted to protection from the la
rabbits by using wider rolls and to protection from both me
mice and rabbits by using wire of finer mesh and by pressing
lower edges into the ground.

Veneer and other forms of wooden protectors are popular, and
several advantages when used for cottontail rabbits. When
permanently upon the trees, however, they furnish retreats for i
pests. For this reason they should be removed each spring. V
the labor of removing and replacing them is considerable, they
the advantage when pressed well into the soil of protecting from
mice and rabbits. They cost from 60 cents a hundred upward,
are much superior to building paper or newspaper wrappings.
writer has known instances where rabbits tore wrappings of buil
paper from apple trees and in a single night injured hund
"Gunny-sack" and other cloth wrappings well tied on are effe
protectors. Cornstalks furnish a cheap material for orchard pr
tion when cut into lengths of 18 to 20 inches, split, and tied
the flat side against the tree, so as fully to cover the trunk. I
ever, they last but one season and putting them in place inv
much labor.

OTHER MEANS.

Few of these methods for the protection of individual tre
orchards or elsewhere are applicable to young woodlands or f
plantations where trees grow close together. In these cases the
remedy is the destruction of the animals or their exclusion by
nettings.

Clean cultivation, generally, possesses advantages in preve
rabbit depredations, since it reduces the number of places of r
for the animals; but rabbits go long distances in search of
especially in winter, and clean cultivation can not be applie
the western plains, where dense windbreaks are essential to succe
orcharding.

Feeding rabbits in winter to prevent their attacks on orchard
been practiced successfully, on the theory that it is cheaper to
than to fight them. One plan is to leave the winter pruning
apple trees scattered about the orchard. Another is to furnish
cabbage, or turnips in sufficient quantity to provide food fo
rabbits during cold weather. These methods have conside
merit, particularly the first, which seems to give satisfactory re
when both mice and rabbits are present.

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DIVISION OF FORESTRY.

REE PLANTING IN WASTE PLACES ON THE FARM.

BY

elbert

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E PLANTING IN WASTE PLACES ON THE FARM.

By CHARLES A. KEFFER,
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GENERAL REMARKS.

article is purposely confined to the treatment of limited areas rather than the planting of waste lands in general, because it ht that there are very few farms in the United States in which nited areas do not occur, for the planting of which practical ons may be given, while for the larger operations of exten- stes—such as dunes, sand hills, and deforested mountain the methods of technical forestry are more applicable.

most favored region the farm "of which every foot is arable" n seen. Even on the richest of prairie farms the crests of the surface are apt to become impoverished after years of tillage, of the best efforts of the farmer, and when the crops fail to the labor expended on them the land is as surely "waste" gh it were undrained swamp or rocky hillside. In the less populated parts of the country, where land is cheap, the re abandoned when this stage is reached. In the East and hat is, within the forest area, where the entire country was vered with forest, natural reforestation soon takes place, and years the old fields are clothed with pines, spruces, and decid- es, the varieties being dependent upon the adjacent growth. this area the farmer can always control the character of the rowths on the waste lands of his farm, either by planting or by he axe, or both, and there is oftentimes great need of good nt in cutting out inferior trees or undesirable varieties.

arm is to be regarded as the capital of the farmer, which is l at its best only when every acre is producing the most valu- p in the greatest quantity of which it is capable. Unproduc- l is as surely "dead stock" as unsalable merchandise, and just nerchant finds a higher rate of profit in some lines of trade others, so the farmer finds certain fields more profitable than Both merchant and farmer are forced at times by the exigen- ousiness to continue the less profitable investments, and he is ccessful who turns them to the greatest possible account.

hin-soiled ridges of the farm, covered, as they may be, with rowth, fulfill a threefold purpose: they form a wind-break to cent fields, increasing thereby their productiveness; they hold ting snows, and insure their slow melting, thus prolonging the opportunity for absorption of the snow water by the adjace of lower elevation; and they prevent late and early frosts by air currents and controlling their direction.

Few farmers seem to have realized the great value of a close- thick-foliaged grove as a conservator of moisture. The effec of a wind-break depends upon its location, density, exte height. Well-planted groves, set thick at the borders, es with coniferous trees, located on the crests of the ridges in th farms of the Mississippi and Missouri valleys, would do mucl breaking the force of the winds which blow so constantly, pr the crops on the sheltered slopes and forming protected run stock in winter. The snows accumulating in such groves ar from the sun, and long after the adjacent fields are bare the slowly melting and the water trickling down over the plowe which are thus thoroughly saturated.

It is not to be supposed that limited plantations, confine waste places of the farm, would have an appreciable effect on eral climate of a region, for the influences must be great affect atmospheric conditions over a wide area. Locally, l the planting of hilltops and the consequent heightening of el will often result in the creation of air currents that will prev air from settling in the lowlands between, thus obviating lat and early autumn frosts, and this protection can be made more if the configuration of the neighboring lands be studied wit to creating the strongest possible draft.

In regions where tender vegetables and fruits are largely cu such protection may be of primary importance, and the cle adjoining hill crests and slopes will often result in serious dist of the local climate.

The great utility of forest plantations in saving snow wat adjacent fields has been mentioned. The summer rains are al to the farm by the same means. Following the deep-descendi of the trees, they are retained in the lower strata of the soil a pass to the adjoining lands and are brought within reach of t ing plants. Such plantations are beneficial also in checking tion from the growing crops by breaking the force of the win utility is of the utmost importance in the Western States, wh are no natural groves except near the rivers.

Situated on the crests of slopes whose sides, together with lands between, are under tillage, a forest plantation has mucl value as a wind-break than where the order is reversed, or level ground. As the winds are in general parallel to the ea face, any obstruction which turns them upward on a rising s protect the land beyond such slope. The matter of protectin at crucial periods of its development is a vital one in Western where it not infrequently occurs that hot south winds sweep y while the grain is in the milk or dough stage and completely . Instances of fields protected from such storms by well-grown plats are not uncommon. Windstorms of great severity are frequent occurrence in the spring, when the young grain is y twisted off at the surface of the ground or the soil is so blown s to expose the roots. It is as a protection against such storms e planting of thin-soiled ridges and fence lines and of the por- the section-line highways not needed for the purpose of travel d.

eneral, the climatic conditions of the forested area of the country s extreme than those of the plains, but with the record of the ecent drought years the need of moisture conservation is appar- ke in the East and West.

le in the West the thin-soiled ridges are best devoted to tree for wind-breaks and snow catches, throughout the Eastern outhern States such localities should be kept in trees for the tion of erosion or gullying, one of the most troublesome results ge.

general action of the elements in uneven or rolling surfaces ably tends to carry the more fertile top mold of the higher l, or at least the decaying vegetation on the surface, to the levels, which thus relatively increase in fertility at the expense elevations above them. In addition to this general tendency have been deposited throughout the Northwestern States, by and water action, drift soils containing a great quantity of ers, which are especially thick on the high ridges, making their ation very expensive. In many localities throughout the Mis- i Valley the trend of the underlying strata of rocks is upward, coming so close to the surface in the ridge lands as to render vorthless for cultivation. Along many river and creek valleys ls which confine the lowlands rise so abruptly as to make cul- n impracticable. These and many other special cases which be mentioned constitute the waste highlands of farms, all of should be devoted to forest-tree culture.

s, as has been seen, can exist and make a profitable growth on too poor to support farm crops. When planted in the thin soil mestone hill crest, they may make very slow growth during the w years; but as the soil becomes shaded by the tree tops the becomes more rapid, and when the trees have attained a strong ld, their roots penetrating the crevices of the rocks to the water they grow with additional vigor.

it is not to be expected that as vigorous growth can be secured se high waste places as in the lower, moist, and deep soils. se the white cedar, the cypress, and the tamarack are found in s, where the surface of the soil is under water more than half ar, it does not follow that this is the ideal condition for them;

neither must it be thought because scrubby red-cedar tree lodgment in the limestone outcrop of the Kansas River bluffs t sites are the best for their growth. Such instances only prove t capability of trees to endure adversity, and show that there waste places in which they can not grow.

One has only to recall the general character of the waste p the farm to realize how little can be gained from cropping the ridge soils are too thin to support a growth of cereal crops; the soils are too wet for tillage; the cultivation of irregular plats extent becomes too expensive, by reason of the difficulties c ing, seeding, and harvesting. Once in trees, these difficul reduced to a minimum. The thin soils of the ridges are p from the weather by the tree crowns, and their decaying folia ually increases the fertility of the soil.

Of the planting of swamp lands on the farm, little need be the reason that such lands, properly drained and managed, valuable for tillage to be used for tree culture. There is dep them not only the decayed vegetation by which they have be ered for hundreds of years, but also much of the fertile m which the descending waters have brought from the higher lev however, drainage is impossible, such land is much better with trees than standing idle. Throughout the irrigated dis the West many places also are made too wet for tillage by from the ditches. Such places, if properly underdrained, ma tinued in cultivation without especial difficulty, but if for an drainage can not be accomplished the "seepage spots" can b ably planted to trees.

The odd corners and fence rows of American farms represe aggregate a great quantity of unproductive land, which n planted to trees. Such limited areas, often composed of bu square rods or very narrow strips, can not be treated as fo trees must be grown on them for special purposes, in which production will hardly be considered.

The highways throughout the farming districts of the Unite may be bordered with trees, which, while giving shade, may as living fence posts, or may become valuable nut orchards any event will afford protection, in winter and summer alik traveler and to the adjacent fields. In Minnesota, Wyom other Western States the highways are at least 66 feet wide, a a hundred. These tracts, separated only by wire fences f cultivated fields, are not merely waste lands, but, for the m veritable propagating beds for noxious weeds, which cause m to the farmer. Try as he may, he can not protect his lan Russian thistle, mustard, and the numerous other weed pest as these broad highways exist as a seeding ground for them. were planted to trees, with a vigorous undergrowth to pro

e of the soil, they would not only make any weed growth impossi-
t would also be a potent means of preventing the dissemination
ds from one section to another, by arresting them when car-
the winds. In many of the Western States the farmer is per-
by law thus to plant a portion of the highway with trees.

another form of waste land is to be considered; and here the
living within the forest area is much more concerned than the
dweller. Had the adaptability of soils to tillage been made
sis of clearing lands in the early days, there would be less talk
in" soils now, for on many farms lands were cleared which
never have been stripped of their first cover. Steep hillsides,
slopes, highlands with hardly a foot of soil between the surface
e underlying rock, have been denuded of their forest cover, and
ubsequent tillage has been all but profitless to the farmer.
onstant cropping they have become so impoverished that their
tion has been abandoned. Yet, they have still enough fertility
port a vigorous tree growth. On many New England farms
in lands have been planted to white pine with the most encour-
esults. In many rocky, drift, eroded, and exhausted hill farms
s a depth of soil sufficient for the requirements of all varieties
s, and the farmer within the forest area has thus a wide range of
in the selection of trees. He may grow timber for railroad
r posts, for telegraph poles, for lumber, and for many other
es, using the species that is best adapted to his need and to his
y.

e Southern States the loblolly and short-leaf pines can be quite
ily grown as the white pine at the North. The loblolly seems
ider the abandoned fields its heritage, for throughout the lower
ic and Gulf States it quickly covers the old fields with its seed-
which grow rapidly.

THE FARM NURSERY.

n such species as catalpa, box elder, black locust, green ash,
elm, and silver maple can be bought for less than $2 per thou-
r strong one-year old plants, it would seem cheaper to purchase
o grow from seed. But with land, tools, and teams at hand, a
tree nursery can be cultivated at very little expense, and the
, by gathering seed of the native trees, and purchasing desira-
ds not to be had at home, can grow on a fraction of an acre
gs enough for an extensive plantation.

he broad-leafed trees, the silver maples, elms, poplars, cotton-
aspen, and willows ripen their seeds before midsummer. These
be planted as soon as ripe, care being taken not to cover the
seeds too deep. They will germinate in a few days, and by
n will be of a size suitable for transplanting.

he species whose seeds ripen in autumn, those of the tulip,
a, honey locust, black locust, and Kentucky coffee tree should

be thrashed from their pods when gathered and kept over w
a cool place where they will neither dry out nor mold. Bir
soon lose their vitality if permitted to dry, and they should b
in close boxes or jars and kept over winter in a cool cellar.
the soil is moist in the fall, birch may be sown before the ground
but in the dry soil of the plains the seeds should be kept ove
They must be sown in beds shaded as for conifers, and cove
lightly. The seed usually ripens in August in the norther
and should be gathered at once, separated, and stored until
time.

The sprouting of the seeds of other broad-leafed trees of th
ern forest flora is hastened by subjecting them to the action
This is accomplished either by fall planting or by mixing t
with sand and placing them in boxes on the north side of
building or other protection from the sun, whence they sh
planted as soon as possible in the spring, or even, when the
is sufficiently thawed out, in late winter. The nuts and aco
be simply spread on a well-drained surface and protected fro
by a few inches of leaves held down by boards; but they
subject to the depredations of rodents when thus disposed
seeds of fruit trees, such as cherry, mulberry, osage oran
crab apple, and hawthorn, should be separated from the
maceration and washing before storing. Cherry and mulbe
ripen during the summer, and as the fruit is much relished
watchfulness is necessary to get them. They may be sligh
after washing, and then mixed with sand. Some seeds, nota
of the hawthorns, are apt to lie over two or more years. G
tion of such refractory seeds is hastened by soaking in wa
tinuously for a week or more before planting.

When the soil is moist in the fall, the seeds of all trees whi
after midsummer may be planted, and thus the labor of s
saved. But spring planting is usually more satisfactory,
uniform conditions can be better maintained where the see
been properly stored. The soil is also usually in the best c
for receiving the seeds in the spring, and lighter covering is

The forest-tree nursery should be placed in deep, moist, well
loam, and should be thoroughly cultivated. Hand weeding i
tant, for the tiny seedlings of many trees are very delicate and
vigorous grasses will quickly choke them out if left unpr
Where a large nursery is made, frequent use of the harrow
cultivator is most desirable, for it keeps a dust blanket on
face of the soil, which prevents excessive evaporation and ins
most perfect soil conditions obtainable through culture.
attention is a requisite of successful nursery management.

Seedlings of box elder, silver maple, red maple, catalp
locust, cottonwood, willow, and mulberry are rampant gro

ed, and then growth may be checked, so make transplanting
ifficult, by sowing the seed thick in broad drills. Black wild
, the elm, the ash, honey locust, black walnut, tulip, crab
hackberry, linden, and coffee tree are of moderate growth
sily attain transplanting size the first year. The oaks and the
ees generally, hard maple, beech, and hawthorn will usually
efited by remaining two or three years in the nursery. The
s should be transplanted from the seed bed to the nursery row
cond year, and set in permanent forest the third.

le the cone-bearing trees are more difficult to manage than the
leafed species, it will be found advantageous to the farmer to
is own conifers. Not only are coniferous trees (pines, spruces,
, larches, etc.) more difficult to transplant, but they are disas-
affected by the drying of their roots, and in the operations of
rcial nurseries—digging, storing, and packing—as well as in
, there is more or less danger from this cause. It will fre-
y happen, too, that plants thus injured, unless the injury be
evere indeed, will appear in good condition when received, so
e purchaser accepting them will be disappointed in his stand
ver care he takes in planting the stock. Even should the cost
wing the cone-bearing trees be more than it would cost to pur-
them, as will often be the case if the time of the grower be con-
d, the trees will prove cheaper in the end, because favorable
er can be chosen for transplanting them: they can be dug as
d, and absolutely protected from drying out during the brief
al between digging and planting.

mers living adjacent to the pineries can easily secure seed by
ing the cones just before they burst open and spreading them
hin layer until sufficiently dry to open, when the seed will fall
The same method is used in securing all seeds save the red
, the fruit of which is a gummy berry. The berries of the cedar
l be soaked for several days in water, then rubbed together to
e as much of the gum as possible, when they may be planted or
in sand and kept frozen during winter. A bath in weak lye
asten the cleaning process. The seeds of the remaining conifers
pt dry over winter. They can be purchased of leading seeds-
hroughout the country, and, as a rule, come true to name, though
lty regarding the Rocky Mountain species is sometimes experi-
. As seeds lose their vitality to a considerable degree the second
nd to a much greater degree thereafter, it is important to secure
fresh.

ell-drained, preferably sandy, soil should be chosen and the seed
epared as is usual for cold frames, so that as soon as the seed is
d the bed can be shaded. It should be open to the air on all
and the seed may be sown broadcast in the bed, or in drills
inches apart. The seed should be covered but little, if any,

more than its own depth. Pine, spruce, and Douglas spruc usually germinates in eighteen to twenty days, red cedar in six months, and larch in twenty to thirty days. Shortly aft trees are up, or at any time during the first summer, a disease "damping off" is liable to attack them. This is a fungous growt results in the decay of the tiny seedlings at the ground. It i very destructive. The only remedy is to sow clean dry sand the seedlings and withhold water for a few days. This is not effective, but it will usually check the disease.

The shade for the seed bed is variously made. In the large eries it is usually a shed, roofed and sided with laths, but this be too expensive for a farm nursery. Useful shades are ma laying brush across supports or by bunches of rushes or swam similarly placed, but of course these are more difficult to k order. Where proper attention is paid to ventilation, an inexp shade can be made by tacking cheap sheeting to a frame upon supports running along the side of the bed.

It may be advisable sometimes to purchase one or two ye seedlings from reliable growers. They should be planted, in beds, about 3 inches apart, in rows 6 to 12 inches apart. It necessary to keep them shaded one to three years, according t rate of growth. The oftener the cone-bearing trees are transp before being set permanently the better, as by this process the of fibrous roots close to the collar is encouraged. Especial car be taken in handling conifers to prevent their roots from dry the least, as whenever the roots dry it is almost impossible to the trees live. The seedlings should be packed in damp moss nursery, and as soon as received the roots should be puddled in mud and heeled in in a shaded place. The heeling in should b fully done, the fine soil pressing close upon the roots, but not co the tops. In a shaded place the trees may be left thus un roots begin growth. In planting it is best to carry the tree bucket, with just enough water to cover the roots. They sho planted firmly and be well trampled, and a little loose soil dust the trampled surface to prevent baking. No tree should be se deeper than it stood before, and this is specially important in planting conifers.

Conifers are ready for setting in plantations when from tw years old. Larches can usually be set when two or three yea the pines and cedars when from three to five years, and the s when from four to six years.

NOTES ON VARIETIES AND METHODS.

The Division of Forestry has frequently issued cultural n the leading economic species of American timber trees, and m horticultural societies, notably those of Kansas, Nebraska, and Minnesota, have published manuals of forest-tree culture, t detailed information for special regions is not lacking. While s true in a general sense, little accurate information of the s of planting in waste places is available. In the West, where plantations have been attempted most extensively, the site n for the groves has been determined primarily by convenience, has seldom happened that the waste places have been selected. forest area little planting of any sort has been attempted on Consequently the actual data of the results of waste plantings ms are few.

idly speaking, the same rules which are practiced in forest ng in general are applicable to the waste plantings of farms; include the adaptability of the species to the locality, attention light requirements of species, and to their rate of growth.

idge or high land planting it must be remembered that the soil h less moist in such locations than in the valleys and lowlands, he winds cause increased evaporation, and that droughts are ally severe. Trees requiring a generous supply of water will succeed well in high, thin soils. This is particularly true of the , where not only a limited rainfall but excessive evaporation the water supply much smaller than it is within the forest area. can be no doubt that conifers will prove the most useful trees, ass, for such locations. This is suggested by the natural tree ng of the Rocky Mountains, where the exposed highlands are d with pines, spruces, and firs to the tree line, while broad- species are found only fringing the streams in the valleys. But rmer who attempts to cover bare ground with a plantation of rs will find it necessary to replant portions during several suc- e seasons before a good stand is secured. The reason for this nd principally in the difficulty of transplanting and in the light ement of the conifers, which changes materially as the trees older. Almost all species of conifers are benefited by at least l shade during the first few years of their existence. As they ce from the seedling to the sapling stage, those which are most equiring, notably the larches and pines, are less tolerant of the of their neighbors, and reach up in an effort to spread their s in the full sunshine, but it is a well-known fact that the pine endures the shade even of such densely foliaged species spruces during its infancy. Hence, it would seem best to the ridge plantation with broad-leafed trees, with the intention roducing among them, in the course of four or five years, an number of conifers.

he North the birches (*Betula lutea* and *B. lenta*) and aspen *lus tremuloides*) should prove useful for mixing with conifers, h we do not know of an experiment of this kind. They are light-foliaged species, and while they are ordinarily found nea they have succeeded well in the dry prairies of the eastern p the Dakotas. They are the natural neighbors and nurses of and spruces in the Minnesota and Wisconsin woods. The fi to appear on a great "burn" (a region where the forest has be by fire) are quaking aspen and the birches (*Betula lutea*, *B. pa* and *B. lenta*), and in their wake, if ever, the conifers appear

Throughout the West a mixture of such broad-leafed s box elder, silver maple, black wild cherry, bur oak, white elm birch, and green ash will be found useful in ridge planting, a of the sand-hill region of Nebraska the Russian mulberry, and black locust may be added. Of these, the species the most shade during youth are named first. It will be at once that several of these kinds are moisture-loving t those here named have been grown in dry situations with a of success. The box elder and silver maple are short liv grown in the ridge lands of the West, but during their fi they grow vigorously, and they will endure long enough to nurses for conifers until the latter are established. Black wil while not extensively planted, has been grown successfully i parts of Kansas, Colorado, and South Dakota—localities co sufficient area to warrant its extensive use. It has the furth tage of being a shade-enduring tree during youth, a point importance in the West, where comparatively few such succ endures drought better than box elder or silver maple, bein the hardiest species in this regard.

White elm, while a species of the greatest hardiness, is less in highlands than either wild cherry or bur oak, and is princi ful in plantings on such lands in giving variety. Bur oak ha a most useful species in highland planting. It grows very sl ing the first few years, making but a few inches increase each year, and seemingly suppressed by its neighbors, but at t Dakota Experiment Station, in a mixture of bur oak, elm, elder, the best bur oaks now equal the box elders in height, a years' growth. At the Kansas Station bur oaks planted on h stone land, between rows of catalpa and black locust, have much height growth, being cut off every winter by jack rab vigorous shoots push out each spring, showing sufficient ro opment in spite of untoward conditions. The black waln adapted to highland planting in the West.

In the use of such varieties as are named above, fully two the trees should be of the dense-foliage kinds, and the r should be mixed with these so that each of them would rounded by dense shaders. They should be set not more th feet apart, not only because they will most quickly shade th and thus prevent weed growth, when close planted, but b

. During the first five years more or less damage is apt to rom the breaking of the trees by heavy snows, but this injury m permanent, if the broken trees are pruned promptly in the It is unnecessary to leave blank spaces for the introduction fers. By the time the broad-leafed trees shade the ground— three to five years—the conifers may be inserted where trees iled, and may even be introduced between the rows. It is lly desirable that spruces and cedars be set thickly toward rgins of the plantation, as they form thus a protecting wind for the more central trees.

ng the conifers which have been most largely tested in Western g, the European larch, Scotch pine, white pine, Austrian pine, spruce, red cedar, arbor vitæ, and white spruce are most n. Of these, the white pine, Norway spruce, and arbor vitæ little value west of the Missouri River, although some fine ens of all these species can be found in the counties bordering ver. Among the Rocky Mountain conifers that would seem lly adapted to the West are the bull pine and Douglas spruce. European larch has been extensively planted in the Mississippi and it is especially useful in the planting of thin-soiled ridges. antation on such land at Ridott, Ill., the larch is easily the e, with white pine and Norway spruce following in the order These species were originally planted in alternate rows with eafed trees (walnut, ash, etc.), which they completely sup-, very few of the latter being alive after twenty-five years. In e larches were thinned out, and made each from two to three osts 7 feet long, many of the butt posts being 10 inches in er. The remaining conifers stand from 30 to 40 feet high, from 3 to 8 inches in diameter. They include white pine, pine, Norway spruce, and arbor vitæ. The larch is sprawling th during the first few years, after which a leader is formed growth is very erect and straight. The species is deciduous, successive crops of leaves during the course of twenty years mulch so dense as to quite prevent weed growth. In Europe h is commonly used as a nurse for the pines, as the latter do er in the slight shade of the larches, which grow more rapidly thinned out as the pines approach their principal height This mixture has also been practiced at Elgin, Ill., with the atifying results.

e drier parts of the West the white pine does not succeed, but out the prairie States it can be successfully grown in ridge Beyond the Missouri the Austrian, Scotch, and bull pine will d better adapted to the climate. So, too, the Norway spruce useful in the dry region as are the Black Hills white spruce Douglas spruce.

Within the forest area—that is, in the States where the wh
try was once covered with forest—different conditions preva
much greater proportion of waste land is contained in the fa
is found in the prairies and plains. These lands consist l
hillsides so badly washed as to be untillable and rough fi
pastures in which the impoverished soil will not produce a
ble crop. In the northern regions a large part of the hill c
made up of drift soils, of a characteristic clay loam, deep, m
well adapted to many kinds of tree growth. Farther south
are composed of granitic rock, which is still in process of di
tion. These soils are moist and in every way favorable to tre
as is indicated by the number of varieties and the great dev
of individuals standing in them.

The rapid-growing tulip tree, which furnishes the poplar t
commerce, succeeds well in the moist hillside soils of the A
region, and should prove a valuable species for mixing with
dense-shading forms, such as maples and beech. The slow
oaks, especially such species as the red (*Quercus rubra*
(*Q. velutina*), bur (*Q. macrocarpa*), white (*Q. alba*), and
(*Q. prinus*), will also prove useful. Of these the black and
are much more rapid growers than is usually believed, and a
found worthy of a place in a mixed planting. The tulip po
the oaks are best introduced sparingly into farm mixtures, at
of from 24 to 50 per acre among other forms. They will th
ultimate trees, not interfering seriously with the develo
the remaining forms, but reaching their full size when these h
mostly removed. If planted for its timber, the black walnu
managed in this way also, though the walnut is essentially
the valley as compared with hillside locations. The white
should succeed well on clay hillsides, and when well establi
be treated profitably as coppice.

Of slow growth during youth, the sugar maple (*Acer sac*
is a most useful species in soils of this character, both on ac
its forestal and its economic value. It endures the shade
trees to an unusual degree, and thus forms a fine second to su
growers as black locust, tulip tree, etc. When these are
the maple develops more rapidly, and the foundation of a f
sugar orchard may thus be secured. The beech is a neglect
America, though one of the most available forms know
European forester. Like the sugar maple, it likes a deep, m
and does not succeed in the prairies; but within the fores
should prove one of the most useful shade-enduring species
side planting, especially on northern slopes.

In all waste planting on Eastern farms the use to be ma
wood crop is a more important consideration than in the We
the incidental value of the plantation is of equal if not

rea is there a sufficient lack of fuel to make planting for this
of any importance. Broad-leafed trees, except as they yield
l for stakes and posts, repairs, etc., are too slow in their
ment to make an attractive crop to the farmer, and hence the
and pines would seem to be the most promising varieties to
here a money return is looked for, unless the waste land is
lly adapted to the growth of osiers or hickory coppice, or some
reason exists for the planting of hard woods.

a hillside fields are abandoned, they are soon covered with a
of bushes, and seedling trees of many kinds appear. As a
e natural mixture thus spontaneously produced is not of much
How can it be improved? Where there is a soil of considera-
th and sufficient moisture, even though the land be "worn
e best oaks, chestnut, and hard maple can be introduced, the
by pressing the acorns and nuts an inch into the soil, cover-
h the foot, and the latter by sowing seed in hills. Such plant-
be done without regard to the existing growth and without
ing it, all these species taking a strong hold on the soil before
wth advances, and hence being comparatively indifferent to
the early stage of growth.

nd of conifers is more difficult to secure. Usually the surface
waste lands is so covered with moss and other débris that seeds
oadcast and left without further care fail to come in contact
e moist soil, and hence fail to germinate. Successful seeding
en been accomplished where the fields have been surrounded
ure trees and have been undisturbed by cultivation during a
ar, thus giving the pines an equal opportunity with less desira-
ies to sow their seed in the soil. Where the seed can be har-
n, there is a reasonable prospect of a stand; but it will usually
d more profitable to plant the young trees, using such as have
e or two years in nursery rows after transplanting from the seed
n the spring, when the soil is moist, hillside fields and pastures
planted thus to conifers with a dibble or spade, the distance
epending upon the growth already established. On clean land
s should stand close, not more than 4 by 4 feet. If there be a
rable soil cover of brush which can be used to nurse or protect
ng plants, these may be set in at the rate of 680 to the acre
feet), or even less. Even in such cases thick planting is the
sirable, using a mixture of dense-shading (spruce) trees with
eding species, such as the pines, or distributing the pines
larch seedlings, which grow very tall and slender and have
good neighbors for the pines.

re the white pine is native, a successful method of planting
ke up the young seedlings in the woods with the sod in which
ow, thus disturbing the root as little as possible. This is much

slower than where nursery plants are used. In clean fields m customed to the work can easily set 1,000 trees per day, whil workmen can almost double this number.

Close planting is less important in the Alleghany regio there is an abundant moisture supply, than in the dry coun of the Mississippi River. In New England many successful set pines not closer than 10 by 10 feet (435 per acre). The to such wide spacing is that too great a growth of branches r the lower part of the stem, producing knotty timber. should be sparingly done, the ideal stand during the first eig being one in which the trees are never so far apart that the will not touch each other when swayed by the wind, and du first fifty years the trees should stand so close that the branch each other when still. This condition is best secured by sl frequent thinnings (seven to ten years apart) during the most rapid growth. The increasing demand for box timbe manufacturing districts of the East provides a market for similar wood when 35 to 50 years old, thus permitting a sho of rotation in the forest management of waste lands in Easte and overcoming a principal objection to forest planting.

In all ridge planting, whether within or beyond the fores leading purpose is the improvement of the soil, and this attained by close planting, which not only protects the sur from wind action, but also retains the leaves where they f enriching the soil by their decay.

The stand secured from any planting will of course depe the conditions of soil and climate at the time of planting and out the season, as well as the skill with which the planting Climatic conditions play so large a part that there is always less danger of partial failure, especially with conifers. W forest region success is much more certain than in the plain under favorable conditions at planting time, a stand of 60 pe the conifers set should be considered satisfactory. With no proportion living than this, replanting would be necessary th ing spring, unless the blanks were so situated as to make with cheaper deciduous forms possible. The aim of the plant be to have the trees which he designs to stand until matur tributed in his grove that they will each have the largest amount of space after the remaining trees have been cut out. when for any reason the conifers desired are expensive, if th intends to make his grove of coniferous trees, he may plac by 8 feet, 12 by 12 feet, 16 by 16 feet (680, 302, 170 per acre) at wider intervals, and fill in the spaces to 4 by 4 feet or such trees as box elder, silver maple, Russian mulberry, black locust, etc. Of these the first three named would fulf temporary office and might be removed within ten or fifteen ime the others would have attained useful size. These could ned out from time to time, as necessary, leaving the land to ifers alone within from thirty to fifty years of planting. Here if due regard to the light requirements of the several species n observed in planting, the trees will be found in regular order, ht-demanding kinds as the pines and larches being surrounded shade-enduring spruces; or if only one coniferous form has sed, the subsequent thinning will be so managed as to give to the remaining trees the largest possible amount of light and It will be readily understood from these notes that the amount , spruce, or larch that may be produced on an acre within a ime—as in fifty years—will depend quite as much upon the nt which has attended the thinnings as upon favorable condi- soil and climate. Fifty thousand feet, B. M., of white pine has roduced at 50 years of age from natural seeding with the aid ful thinning. This must be considered an unusually large , and one-fourth as much would be good in ordinary practice.

PLANTING TO BIND SOILS.

of the waste planting of farms will be done to bind the soil of lsides which have been worn to gullies by long exposure and ng. One of the best trees for this purpose is the black locust, has a great root development and is one of the toughest woods. ee is a native of the rocky hillsides of the Alleghany region, cceeds well in all kinds of soils. It is a rapid grower, attain- ize suitable for vine stakes, intermediate posts, etc., in about ars. It reproduces itself freely by sprouting, and spreads where planted pure. It is a thin-foliaged tree, and planted s not a soil improver, but it can be established where more le species in this regard can not gain a foothold, and these introduced later.

locust is much subject to the attack of a very destructive borer, s insect is less common than formerly, and its ravages are d to a minimum in mixed planting. Few broad-leafed species reater value than black locust for farm uses. It is the hardest e most durable of our trees. Commercially, the timber fur- the best wooden pins or treenails used in shipbuilding, and it used for wheel hubs.

cond important form of planting for the purpose of binding that used in controlling the direction of streams by the plant- villows on their banks. East and West much fertile farm land ered comparatively waste by the windings of streams, which n and out, occupying wide stretches of bottom lands and mak- m useless except for pasturage. If simply a straight channel or such streams, they soon wear the banks and are again uncon- . By planting willow cuttings in the sides of such cuts, a first row near the water at its low stage and additional rows in and top of the cut, the roots soon bind the soil, holding it ag wearing action of high water. Either white willow or osier used for such planting. Where fuel is scarce, the rapid-growi willow will be found most useful. In such locations it attain eter at the butt of 5 to 8 inches in ten years, and as it sprout from the stump it can be treated as coppice and will furnish of small wood for many years. Where there is a market f osier willows can be profitably grown in such waste places. cies most commonly used is the red osier (*Salix purpurea* va *midalis*). Cuttings from well-ripened wood, 12 inches long, a stuck in the washed banks. The osiers are more profitab given high cultivation, and land too wet for corn but yet of cultivation is well adapted to them. The soil should b plowed or spaded, and the cuttings set to the top bud in ro feet apart, 1 foot in the row. The withes, or rods, should be to the ground every year, including the first, in order to se strongest growth.

THE NUT TREES.

For highways, fence rows, and odd corners, those waste lan often contain some of the most fertile soil in the farm, the are especially available. The black walnut has been largel the West as a fence-line tree, because of its rapid growth, nuts, and ultimately valuable timber. It prefers a deep, rich is intolerant of drought, but in suitable localities it is a s tree throughout the country east of the one hundredth meri south of the Minnesota line, though grown as far north as Min The chestnut, like all nut trees, varies greatly in the quality of and the farmer has abundant opportunity of selection in choo for planting. Although limited in its natural range of the east of the Wabash and Kentucky rivers, it has been suc grown in western Missouri (Kansas City) and central Iowa, probably succeed as far west as the Missouri River. Unlike nut, the chestnut succeeds well in highlands. Experiments ing Spanish and other improved chestnuts on the native st been entirely successful.

The pecan has attracted much attention in the Southwes the past few years as a desirable nut tree, and as such deserv tion in this connection. The pecan is of even more limited range than the chestnut, its northern boundary being in Indiana and Illinois and its eastern line about central Kentu is thus essentially a Southwestern form, and is worthy of th attention of farmers in that part of the country as a means o waste places productive. It is successfully grown throughou est area south of New York. A great range of choice is po selecting nuts for planting, as they vary greatly even in the sa

shagbark hickory is much less particular in its soil require-
than the pecan, although a closely related species. It occu-
ndy ridges and clay hillsides as well as the richer lowlands,
well worth consideration as well for timber as for its fruits.
bits being understood, it should be a useful species for waste
lanting. In its natural state it grows in open groves with hazel
r undergrowth. While usually more or less mixed with other
t is often the dominant form over considerable areas. It is a
emanding tree, and is difficult to transplant unless specially
ed by the cutting of the taproot a year previous to setting.
ocker nut, variously called Missouri nut, bull nut, king nut,
more southern in its range than the shagbark, which is found
New England to southern Minnesota. The hickories can be
bly grown as coppice, the cuttings having an established value
p poles.

nut trees are best grown by sowing the nuts where the trees are
d. Along fences they can be grown in open hedge rows, and
their earlier years will fruit freely in such plantings. As they
lder those which bear inferior fruit can be cut out, giving neces-
oom for the remaining trees. If grown on highways, the nut
ill be benefited by being mixed with some low-growing, woody
such as sand cherry, coral berry, wild gooseberry, or some low-
g tree, like wild plum, ironwood, or dogwood. Such under-
will prevent weed growth and thus further the especial
e of the plantation.

e fruit rather than the timber is the principal crop desired,
trees should be encouraged to form large, open crowns, admit-
ght freely, for fruit is produced only under such conditions.
ore, in the planting of odd corners, fence lines, and highways
ut trees, if other species are mixed in they must not be per-
to shade the nut trees, but must be lower growing, or very erect,
ch case but few should be used. The nut trees may require
ursing during the first ten years, to induce them to form a
of proper height, especially in roadside planting, but when this
ned their crowns should have full sunlight. At the same time
species are peculiarly subject to sun scald, especially the hick-
nd white walnut, or butternut (the latter is excluded from this
this account), and this suggests the advisability of mixing with
low-growing tree which will shade their trunks during youth.
North Central States the Russian mulberry should prove a use-
for this purpose, as it is a rapid grower during youth and of
oderate height. Of the shrubs suggested for use as under-
none can gain a foothold until the crown cover has been raised
erably from the ground, after ten or twenty years, so that this
fter consideration, unless all be planted at the same time.

ng the trees of possible culture in waste places the especial usefulness of several may be mentioned. The hardy catalpa of the few rapid-growing trees whose wood is very durable in c with the soil, and it is therefore unexcelled as post timber. not succeed north of central Iowa nor west of the ninety-seventh ian, but within its range it is one of the most rapid-growing tre will prove a useful timber on every farm for posts, stakes, and The European larch, though not so durable in contact with the s be grown over a wider range, and is an excellent post and rail t More trees of this species can be grown to large size on a give than of any other, because of its erect habit. Thus, trees stan by 4 feet can be grown to good rail size without thinning.

The white ash in the East and the green ash in the West sho included in farm planting on account of the usefulness of the ber, when properly seasoned, for machinery repairs. While of growth than the foregoing, they yet attain a useful size for purposes within twenty-five years. Like the black locust, they be scattered among other species to reduce the danger from The white elm yields a tough timber that can be applied to farm uses, and as it succeeds in most locations it should form of all plantations. The hickories, aside from their excellent nu among the most useful of farm timbers, because of their tou and elasticity. The black wild cherry is most useful incident the farm plantation, as it produces a fruit much relished by and has a high forestal value. The timber attains its peculiar only with age, as is the case with the black walnut.

The wood of pines and spruces is of comparatively little until the trees are mature, as it is neither so strong nor so dur that of several species mentioned. The incidental value of thes fers is greater than that of broad-leafed trees, as their leaves ar through the winter, thus greatly increasing their usefulness as breaks. The well-known superiority of the lumber of mature needs no comment. The red cedar is one of the most durable t known in contact with the soil, and the arbor vitæ is only less v as a post timber.

The common cottonwood is one of the least useful trees for planting on the farm, because it succeeds well only in fresh or soils. In the far West it is a useful tree for planting in seepage and it can be well grown in all moist soils. It is neither dural strong, so that its principal value is in its rapid growth, givi early supply of fuel. Of the willows, the leading one is the co white willow, which is especially useful as a wind-break, b willow also likes a moist soil, unfitting it for most waste planti

Walter Mulford

Y. B. Separate 517.

HE OPPORTUNITIES IN FOREST PLANTING FOR THE FARMER.

By

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PORTUNITIES IN FOREST PLANTING FOR THE FARMER.

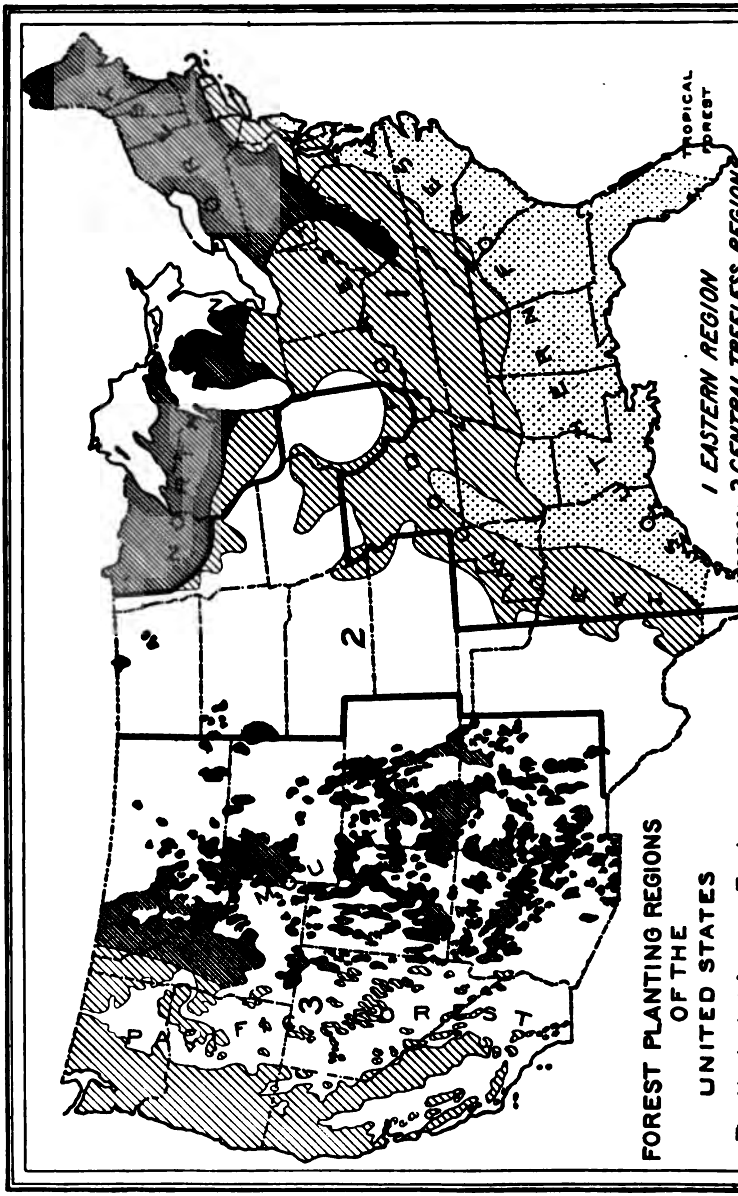
By Allen S. Peck,
Assistant Chief of Operation, District 3, Forest Service.

THE FOREST AND THE FARM.

y is but one of the forms of crop production included under
e. The woodlot is an integral part of the farm and an
factor in its success. Forest planting is that part of forestry
ks to restock and perpetuate desirable timber and to estab-
orests on treeless areas, where they are needed for protective
urposes. Forest planting should not be confused with tree
or arboriculture, for these terms cover only the planting and
rees chiefly for ornamental purposes, while forest planting
the planting of trees in stands of considerable size, in which
ditions are sought.

farming districts of the East, where almost every farmer has
a small bit of the original forest, which he calls his woodlot,
ery general lack of appreciation of the necessity for utilizing
dlots to the best advantage, and of the methods by which
be accomplished. Much may be done by management,
nsists largely in careful cutting that will keep the forest
act, and in removing dead and dying and inferior trees.
however, is very generally needed in order to hasten the
g of woodlots with valuable species. One of the fundamental
of forestry is that the trees in a stand must be sufficiently
ther to be mutually helpful; that is, that their crowns must
ntinuous cover to shade the ground and the tree trunks, in
t side branches may be self-pruned and the trees be forced
ight upward growth. Where there are open spaces they
planted, and where it is desirable to cut a portion of a wood-
much time can be saved by planting instead of waiting for
eproduction. On many farms the tract now occupied by
llot would be more valuable for crops, while on the same
re may be an irregular plat of land or a piece of worn-out or
d upon which it would be wise to plant trees. Planting is
able to check erosion, or soil washing.

In general, forest planting in the United States needs to be as shown on the accompanying map (fig. 17), according to an a central treeless, and a western region.



EASTERN REGION.

The eastern region includes all of the country east of th States. This region in turn subdivides naturally into thr the northern spruce and pine forest, the southern pine forest tral hardwood belt. Of the two broad purposes of forest g, commercial and protective, the first is most important out the eastern region, though in many localities protective g is of chief interest to the farmer. Nearly 35,000,000 acres ast should be planted. Of these 18,000,000 are in the northern 12,000,000 in the central hardwood region, and the rest in f and South Atlantic States.

ands which offer opportunities for planting may be classified cut-over burned lands, not fitted for agriculture, which are tocking naturally with commercially valuable species; (2) nds originally cleared for agriculture which have since proven ble for this purpose; and (3) farm woodlots. Lands of the ss are for the most part owned by large corporations or by the nd do not greatly concern the farmer. They are chiefly in theastern and lake States, where extensive areas which once nds of spruce and pine have been so thoroughly denuded by fire that no hope of natural restocking remains.

abandoned farms of southern New England are striking es of the second class, as are also the lands in the southern chians, once cleared for farming but now ruined by erosion. out the East farm woodlots have so deteriorated that planting d in order to restore them to their highest productive capacity; many farms there are tracts which are now lying idle or are ltivated at a small return, but which would furnish splendid ents if devoted to tree growing.

rea of plantations already made in the eastern region is nearly cres, and 85,000 acres of this are about equally divided between thern tier of States and the central hardwood region.

t planting requires a considerable initial investment, and the elatively higher than that required to start any other form of ork. Therefore protection to the investment is of the utmost nce, and fire is the source of loss most to be guarded against. hings that must be taken into consideration are cheap land, market, a minimum initial cost, and a low rate of taxation. uence of each of these will vary with the locality and the purplanting; for instance, if a windbreak is needed to protect rops, or farm buildings, then the rate of taxation, the market, en the cost of planting will carry comparatively little weight.

NORTHERN FOREST.

ing out those planting problems which are of such magnitude ey must be handled by the State or by large companies, the s part, in the northern forest, will be confined to the restocking woodlots in the various agricultural districts and to the reforof abandoned farm lands in New England.

The New England landowner is realizing more and more th
that although portions of his farm may be "run out" or too
to compete with the better agricultural land of the West in th
duction of annual crops, yet they offer a splendid opportunity
very safe and satisfactory investment in timber growing, and
ever the farm includes sufficient good agricultural land to furni
necessary annual income, the remainder should, by all mea
devoted to a forest crop.

Aside from extensive pitch pine plantations on the sandy a
the Cape territory of Massachusetts and the islands of Marthas
yard and Nantucket, more than 90 per cent of the planting i
England has been with white pine. Other conifers which unde
able conditions have been successful are Norway spruce and Eu
larch. Mature plantations of hardwood are comparatively r

The state governments of Connecticut, Massachusetts, an
mont distributed about 1,500,000 seedlings in 1908, and these
supply the demand. One private firm disposed of a million see
Beginning with the spring of 1907, the state nursery of Ve
started in to distribute about 100,000 seedlings a year.
every farmer in Vermont may wisely do a certain amount of pl
under the direction of the state officials. The most hopeful
for beginning the practice of forestry are the old, weedy bac
tures which are now lying waste. Next in importance to thes
the blank spaces in natural stands, which should be filled in.

White pine is considered the best, though red pine is of great
especially for the drier soils, and the Vermont experiment sta
using Scotch pine on dry sands. Norway spruce is of e
promise for the moist, strong land of the high mountain va
natural spruce land. Small plantations of black locust are
tried for supplying durable posts and stakes.

The conifers best adapted for planting, particularly on th
plains, are Scotch pine, white pine, Norway pine, and pitch
and the hardwoods which promise best are chestnut, red oak,
and sugar maple. (See Pl. XXII, fig. 1.)

The increasing field for forest planting in the New England
is strikingly indicated by the recent increase in the area of
proved land in farms. There was 11 per cent less improve
land in Maine in 1900 than there was in 1890, and 20 per cent
New Hampshire, with the other New England States betwee
two figures. In all, there are 2,500,000 acres in New Englan
need planting.

In New York State the species which are best adapted and
promise highest returns are white pine, red pine, Norway
chestnut, red oak, basswood, tulip poplar, white ash, and, in
places, Carolina poplar. Forest planting is increasing rapidly

in the Adirondacks is a remarkably fine example of tice and planting, and active steps are being taken rities to encourage forestry among the farmers and

ivides readily into three sections where conditions and climate are greatly enough differentiated to ice of planting for each. The southeastern plain water along the Delaware westward and northeast-lue Mountains, which form the northern boundary ebanon, Berks, Lehigh, and Northampton counties. tains comprise a broad belt extending from the of the State southwest to Maryland and West Vir-rn hills include a section in the northwestern part of g from the Allegheny River westward to the Ohio . The second-named region was covered originally ests of pine, hemlock, and hardwoods. There is eed for planting in this region, so the greatest arm forestry are in the other two sections.

rn plain was an early settled farming region, and had its woodlot. Very few of these woodlots are tion, though in some cases the owners have become station, and more or less tree planting has followed. s of cordwood, fence posts, and farm repair material than in any other portion of the State. This fact, alue of the land for agriculture, makes this region a arm planting where quick-growing species will pro- and other timber in a comparatively short time. ting has been done in this section of the State than arly purposes of planting were rather vague. Two ere planted. Of these white pine leads in the class nd black locust of the rapid growers. No great as been attained and the value of the early planting ducational. The great area of the near-by central which is more valuable for trees than for any other irable to devote woodlots on these plains to rapid- Those which seem to give the best promise are red ch, tulip poplar, and, where preservative treatment tonwood, silver maple, white willow, loblolly pine, Catalpa has proven successful enough to justify its soils, and with proper methods of growth it should post tree.

is needed in the central mountains the species hite pine and spruce, and hardwoods such as red tulip poplar, white ash, and basswood.

The western hills section ranks next to the southeastern agricultural value, yet contains a much larger proportion adapted to trees. Here planting will add to the general valu the farm and forest areas. Since there are considerable essentially nonagricultural land separating the agricultural slower-growing species for the production of large timbers profitable, while, as on the southeastern plains, quick-growin may be planted to advantage on many of the farms. Thus ever, very little planting has been done. In the western soil is admirably adapted to white pine, European larch, a woods such as red, yellow, and scarlet oaks, white ash, b honey locust, and rapid-growing species such as cottonw maple, and white willow, to be used in connection with prese

In New Jersey forest planting is rapidly increasing. Fo production the species which have been chiefly planted a pine, Scotch pine, white ash, and white elm, though speci give the best promise are the rapid-growing pines and spruc

In the Lake States, which have a southern hardwood fore northern coniferous forest, forest planting is rapidly in The principal species which have been planted are white pin pine, Norway pine, European larch, and, to some extent, rapid growing hardwoods such as locust, catalpa, black cottonwood, ash, and elm. As in the East, woodlots are rating and require interplanting. Excellent trees for this are the white pine, the Scotch and Austrian pines, and the spruce. The rapid-growing hardwoods which make such an investment farther south can not be successfully grown northern region.

HARDWOOD FOREST.

In the States included within the great central hardwo region the sort of planting which should chiefly interest far have for its object the utilization of waste land on the farm.

In those States which are making the most rapid general the state authorities are issuing publications that contain ad information, are distributing stock from state nurseries, and ducting forest work on state lands, which serve as an object private landowners. In the farming region east of the Appa in Virginia, Maryland, and Delaware most of the land is too for agricultural purposes to be devoted to timber growing other farming regions, however, every farm should have its and in many localities where no extensive timbered areas re planting of windbreaks and shelterbelts is advisable. A rece of conditions in Delaware indicates that the growing of timb without considering the value of forest belts from a protecti

:cellent investment on lands worth not more than $15
·tions of farms which have been worn out through con-
tion may be planted to advantage. The species rec-
: planting in Delaware are chestnut, red and pin oak,
ınd black locust. The last-named tree will do well on
t only in Delaware, but throughout Maryland and Vir-
is one drawback, however, to a locust plantation, and
l-known enemy, the locust borer, which is greatly to be
y localities. Where it is prevalent it is useless to plant
ıer rapid-growing tree which is likely to prove of con-
mercial value when planted on fertile, fairly heavy,
oils in the more northern portion of the State is the
. Excellent trees for windbreak and roadside planting
ean larch and black locust.

the early planting in New England, the farmers of Ohio
ave been the first to recognize the value and importance
ting. There are a number of rapid-growing broadleaf
ed to this section which give early returns and which
loited by commercial nurserymen. In these two States
throughout the central valley district the practice has
rapid-growing kinds. For example, in West Virginia
tern Pennsylvania, walnut, locust, sugar maple, red
, and catalpa have been planted for posts, mine props,
n Ohio, black locust and catalpa for posts; in Indiana,
catalpa, and walnut; in Kentucky, black locust,
poplar, maple, and walnut, principally for mining tim-
s; in Tennessee, locust, maple, and cedar; in Missouri,
st, walnut, osage orange, cottonwood; in Arkansas,
lnut.

: locust and hardy catalpa give excellent returns when
· proper conditions, the most far-reaching and valuable
planting of these species has been to call attention to
timulate general interest in the growing of timber crops.
:nowledge of conditions shows that without doubt the
ther and more slow-growing species is fully justified
mic standpoint. The state authorities of Indiana and
ng a leading part in promoting farm planting. Along
r in southern Indiana and Ohio there is much land now
which would actually produce a higher return per acre
h black locust, or even with some of the slower-growing
uable hardwoods. Nowhere in the United States can
d a more striking example of the need of timber belts
he highest results from agriculture even where there is
re of waste land on any farm. Throughout this district
should make provision for the future by renewing his

woodlot, by planting where necessary, and should see to it t ficient shelterbelts are planted to insure future protection homestead, his growing crops, and his orchards.

SOUTHERN FOREST.

Of the total area of cut-over forest land which is not res naturally, about 70 per cent will reproduce pine if it is protect fire. About 30 per cent, therefore, or more than 5,000,00 will require artificial restocking. While most of this lies wit southern pine forest, there are limited opportunities for pla the Appalachian Mountain region and in the northern por Georgia, Alabama, and Mississippi. Planting thus far has most altogether with rapid-growing hardwoods, such as catal for the most part has been ill advised, and serves as no in whatever of the lines along which planting should progres hardy catalpa is unsuited to this region. For quick returns o sized material, black locust is especially suited to the mount Piedmont sections of Georgia, and white oak is good fo and ties, though for posts it will be best to grow loblol and treat it with preservatives. Carolina poplar grows rapidl South and makes good chemical pulp; but since it has bee that pine can be used for pulp, the value of planting poplar what doubtful.

In general, however, planting is unnecessary throughout thi because reproduction is abundant wherever there is protecti fire.

CENTRAL TREELESS REGION.

The central treeless region includes the States of Illinoi North Dakota, South Dakota, Nebraska, and Kansas, the district of Minnesota, and the portions of Oklahoma and Tex west of the hardwood belt.

Forest planting has been a part of the progress in ag and therefore has been most extensive in the region of best tural development. Nebraska and Kansas lead in the ac plantations. About 840,000 acres have been planted wit central region, but there should be more than 14,000,000 ac

As in the past, planting in this region will be almost en private enterprise, carried on in connection with farming. protection is, and in general will be, the primary object, should be done from the commercial standpoint, since b only profitable species it will easily be possible to secure the advantages of shelter and ornament, and at the same time to revenue from all the plantations. (See Pl. XXII, fig. 2; Pl. fig. 1; Pl. XXIV.)

recently forest planting had declined or was at a
ie older farming regions of Illinois, Iowa, Nebraska, and
ie cutting of mature plantations offset the new planting
; done. Shelterbelts are increasing in the newer farm-
f the Dakotas and Oklahoma, and, owing to their evi-
plantations, interest in planting is now being revived.
interest is shown by figures from forty-five of the prin-
cial nurseries which handle forest-tree seedlings. In
out 24,530,929 young trees; in 1907, 38,540,202; and in
93. Seventy per cent of these trees were hardwoods
it conifers.

age and the necessity of having a certain proportion
n agricultural districts under forest cover have been
istrated; 5 per cent of the prairie region should be
farther west on the plains 3 per cent may very well be
e growing.

Service of the Department of Agriculture is prepared to
al assistance to farmers and tree planters, and since the
have been foremost in the treeless States, the first efforts
ervice were directed toward this region. There has been
ution of literature in these States, and for several years
Nebraska have received more of the Forest Service
1 any other States.

lanting is no longer being practiced so extensively as in
ie total area planted by the farmers of this State is
re than 15,000 acres, but the areas which might very
evoted to tree growing aggregate some 1,500,000 acres.
iefly used have been black walnut and hardy catalpa.

25,000 acres have been devoted to timber growing on
owa. This is but a small fraction of the 2,000,000 acres
be planted in order to keep the proper balance between
d and woodland, and here again forest planting seems
ane. Species which have been planted chiefly are, in the
predominance, silver maple, black walnut, cottonwood,
ow, ash, elm, and catalpa.

tern and southern prairie portions of Minnesota it is
it there are nearly 1,200,000 acres which should be
ere have already been planted about 115,000 acres, and
slight increase in the extent of planting. The species
st commonly planted are boxelder, cottonwood, maple,
nd elm.

akota more than 1,500,000 acres could very properly be
forest trees, in addition to the 52,000 acres which it is
e thus far been devoted to this purpose. It is interest-
iat in general throughout the entire State, which is a

relatively new farming region, tree planting is rapidly on the i
chiefly for shelter and for post production. The species main
are boxelder, cottonwood, green ash, and willow.

About 122,000 acres have thus far been planted in South I
and at least 1,600,000 acres should be planted by farmers.
North Dakota, the interest in tree planting is growing, and, i
tion to the species which have been most popular in North I
elm and soft maple have been used extensively in South Dako

Nebraska has an area of planted timber estimated to be
acres, and there are something more than 2,000,000 acres mor
might be planted to advantage to utilize waste lands and
adequate protection for crops in the farming districts. Wh
braska has deserved and won the name of "Tree Planting Sta
indications are that planting is slightly declining, particularly
eastern portion of the State. As in the other Western Sta
chief purposes of past planting have been to secure shelter
produce fuel and posts. Cottonwood, boxelder, ash, elm, and
have been the species largely planted. Reliable data sho
175,000 acres have been planted with forest trees in Kansas,
least 1,700,000 acres should be planted. In addition to the
species which have been most largely used in Nebraska, black
hardy catalpa, and black walnut have been favorites with the
farmers.

In the prairie region of western Oklahoma over 21,000 acr
thus far been planted with trees. It remains for the landow
this relatively new farming region to plant nearly 300,000 a
the best interests of their section. The species chiefly u
black locust, hardy catalpa, maple, and cottonwood.

The planting of black locust, cottonwood, and catalpa
being done on a rapidly increasing scale on the prairies and
of the western half of Texas. Hardly more than 13,000 acre
however, as yet been planted, and it will probably be man
before the ranchmen in this region will accomplish the plan
the 2,500,000 acres which should be devoted to tree growing

As a whole, particularly for shelterbelts and windbreaks, t
tral region needs to use more conifers.

WESTERN REGION.

The western region includes the Rocky Mountain and the
Coast States. Much of the forest land in the Western S
within National Forests, and forest planting on these lands is
a federal problem. But there are abundant opportunities for
planting in the valleys of southern California and on irrigate
throughout the region. It is essential that more than 2,
acres of land in this region in private ownership should be art

y far the greater portion of this planting must be s or ranchmen.

lands the primary purpose of planting by private cal with that in the central treeless region. Most of rojects are subject to strong winds, and protection orest planting by farmers in California is needed for of watersheds, as shelterbelts for orchards, and for of commercial timber.

lanted timber in this region is 38,862 acres, of which ave been planted by private landowners. A very economically valuable object lesson in planting is f 20,000 acres of eucalypts in California. This preble example of profitable returns from a quick-growing ows the value of further experiments with exotic Jnited States.

cies are used there should be no great difficulty in helterbelts and woodlots on western irrigated lands. ave proved most useful in the limited planting done cottonwood, locust, elm, and introduced species, such ce and Scotch pine, have been planted. The choice of chiefly upon temperature, since moisture can be rigation. (Pl. XXIII, fig. 2.)

nent of planting in California has been more rapid her State in the region. High returns from planeady been secured, and the southern part of the State a great producer of eucalyptus (hardwood) timber especially furniture and wagon stock. It is estimated least 1,000,000 acres of land in the valleys of southern which continued irrigation for the production of fruit but which can be irrigated from time to time, and are he growing of eucalypts. (Pl. XXV.)

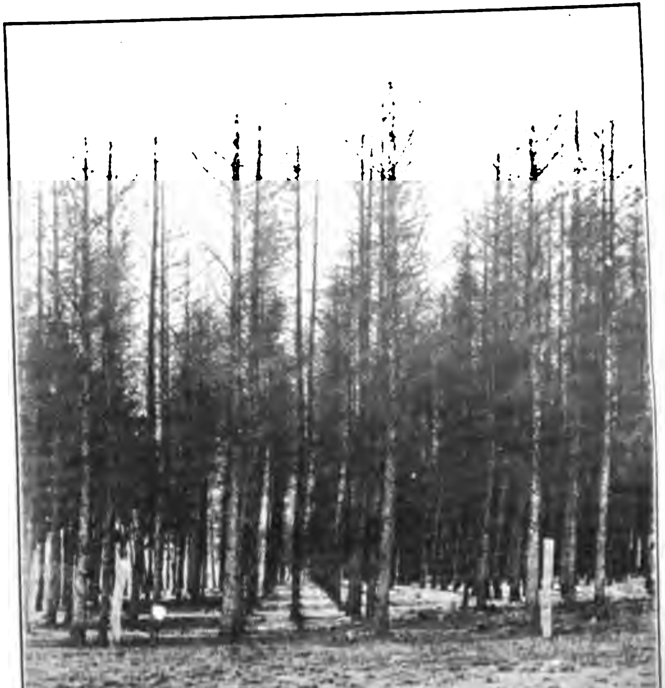
forest lands outside of National Forests lie in Washgon, west of the Cascades, and in California. Possibly nt of the cut-over lands in the former section will be ually to agriculture. Adequate fire protection and anagement will provide for a future timber supply on of these lands. Planting will be a small factor only, tal to forest management, in order to restock areas seed naturally, because of lack of seed trees.

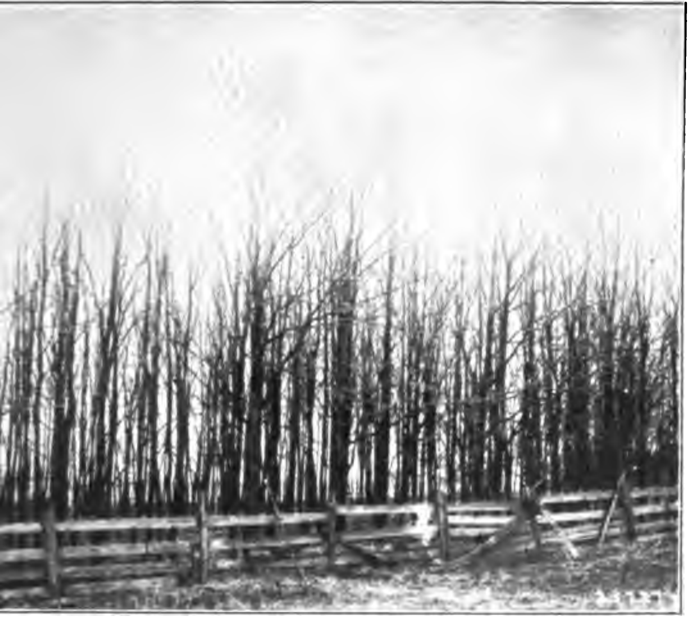
CONCLUSION.

oblems of the various planting regions of the United rs that just as the greater portion of the forest area lies in the East, so the amount of land requiring artiis greater in that region. Conservative lumbering

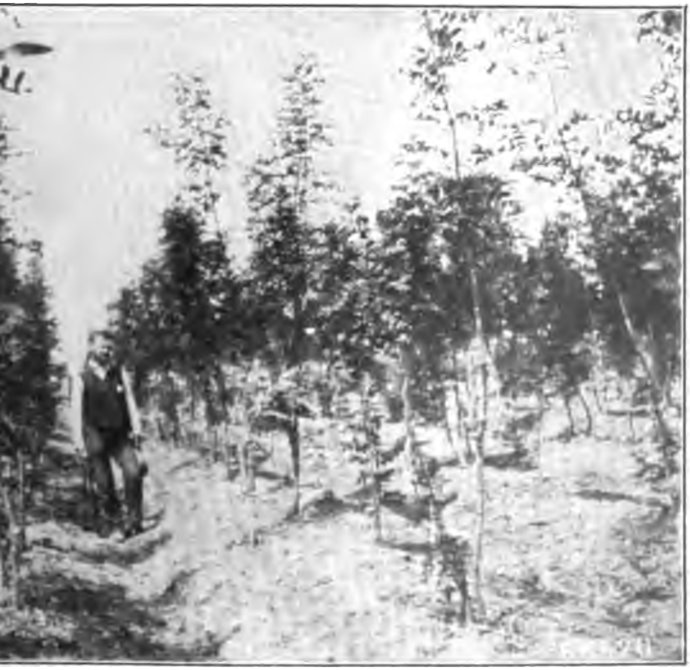
and forest planting within National Forests and by privat
in the West will maintain a permanent supply of valuabl
conifers, but in the East the perpetuation of the best specie
wood is dependent largely upon the activity of the priv
owners. It is absolutely essential that the people of each S
particularly farm owners, should realize the immense impo
individual effort in providing for a future timber supp
quantity of land that can be restored to value through fore
ing by the Federal Government or by the States is in the
small and comparatively insignificant as compared to the g
that must be forested eventually by private landowner
whom the farmer stands first and foremost.

In case the prospective planter finds himself confronte
local problem concerning which he feels the need of special a
should correspond with The Forester, Forest Service, Wa
D. C., provided, of course, that the authorities of his own Sta
in a position to furnish him with the information he desire

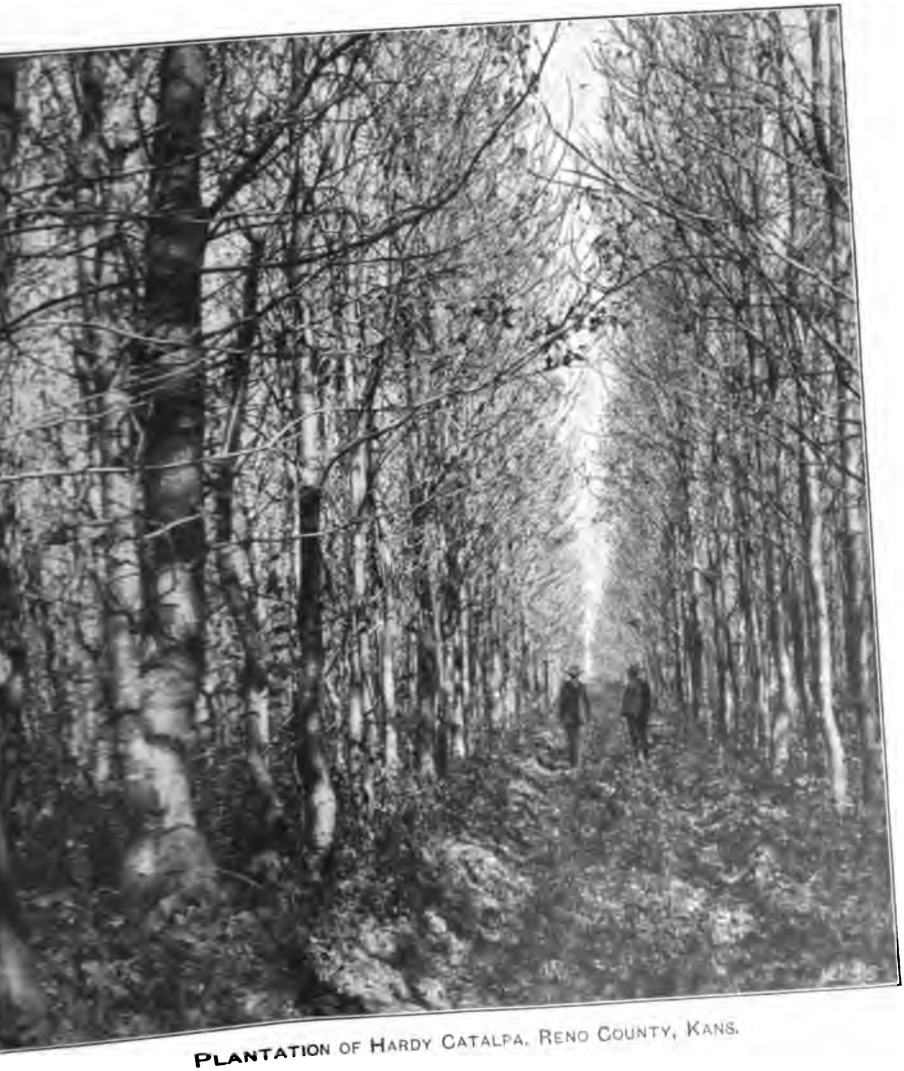




AR-OLD BLACK WALNUT PLANTATION FROM SEED, TIPPECANOE COUNTY, IND.



AR-OLD PLANTATION OF BLACK LOCUST ON IRRIGATED LAND NEAR TWIN FALLS, IDAHO.



PLANTATION OF HARDY CATALPA, RENO COUNTY, KANS.

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OCT 8 1914
Division of Forestry
University of California

BULLETIN

OF

NEW YORK STATE
LEGE OF FORESTRY

AT

SYRACUSE UNIVERSITY

EFORESTATION OF CUT-OVER AND
IDLE LANDS IN NEW YORK

SYRACUSE
1913

OF THE NEW YORK STATE COLLEGE OF RESTRY AT SYRACUSE UNIVERSITY.

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Photo by Hugh P. Baker

THERE ARE VALUABLE FORESTS UPON STATE LANDS IN NEW YORK.

Virgin Forest in Township 40 in the Adirondacks. Much of the larger Spruce, Fir and Beech and Birch are over-ripe and should be removed to insure the proper development of the future forest.

OCT 8 1914
Division of Forestry
University of California

STATION OF CUT OVER AND IDLE LANDS IN NEW YORK.

OF NEW YORK BETTER SUITED TO FORESTRY THAN TO AGRICULTURE.

4,000,000 of acres in the State of New York over 35
000,000 of acres are better suited for the growing of
any other purpose. This is the verdict of the Census
Great State of New York. It is difficult indeed to
this large area of land means, but if it were one
, it would cover the States of Rhode Island, Connecti-
etts and extend for forty miles across the southern
t and New Hampshire. Or it would cover in our own
y all of the section north of the New York Central

w also that out of the 22,000,000 of acres enclosed
s of the State, but 15,000,000 are actually in agricultural
ans that there are 7,000,000 of idle acres in the farms
which should be made productive. It is probable that
arge area is actually nonagricultural, but without ques-
area larger than the State of Massachusetts enclosed
ns and permanently non-productive. Of the 12,000,000
e of the farms and referred to above, it has been
than half contains merchantable timber, about four
alf of the twelve millions of acres are covered with
aluable growth but non-merchantable; there are then
ions of acres with no valuable growth at all, really in
ste lands.

NEW YORK HAS NO REAL WASTE LAND.

mer in a way to call these essential forest lands waste
New York is land poor in a sense and yet these very
time become a source of large profit to the State.
Europe not nearly as well adapted to the production
nuch of the forest areas of New York is producing
$5 per acre per year. It may be many years before
s will be producing so high an annual return as this
able care these lands will soon begin to be productive
l bear a large share of the burden of the support of
nonwealth.

LITTLE OR NO VALUABLE TREE GROWTH ON DENUDED LAN

What is the condition of these denuded lands at the prese Over much of the area we will find a scattering growth c and inferior tree species occupying the ground or we may abandoned pastures gradually giving up to the extension of th about them. Usually they produced a valuable timber cro past and are capable of such production again. If left to Nature might succeed in time in re-establishing a good forest ever, the often repeated statement that if we will simply pr cutover lands, as they now exist, from fire, that they will so up to valuable forests again, is seldom true. Where a re number of the right kind of mother trees have been left ground, Nature may in time reforest the surface with a fair of timber. There are very extensive areas in New York whe the valuable trees have been cut or destroyed by fire and it many years indeed to bring back anything in the way of factory forest. Over such areas it will be necessary to do a amount of planting before the right kind of forest can be est As the forest lands of New York lie largely in the zone maximum development of the conifers, which are usually ev the future forests of the State will without doubt be made u of rapid growing conifers such as some of the pines and sp

SECOND GROWTH HARDWOOD OFTEN WORTHLESS.

Over lands which formerly produced a hardwood forest, often re-establishes a second forest in a comparatively sh These second growth hardwood or sprout forests are forme from the stumps of trees and in a measure are independent trees for reproduction. It is very different with the conifers greens which with one or two exceptions are incapable of rep by means of sprouts. As certain of our conifers are the m growing trees which we can put onto the land and have that is very desirable for use in the industries, it is prob much of our future forests will be evergreen or coniferous. too much land in the State to-day covered with poor, worthles growth hardwoods. These should be removed entirely and by seedlings of the evergreens. Much quicker returns will b by this clear cutting and planting than can be expected from th growth on the ground, even though some attempt is mad prove it. After the coniferous forest is once well establishe

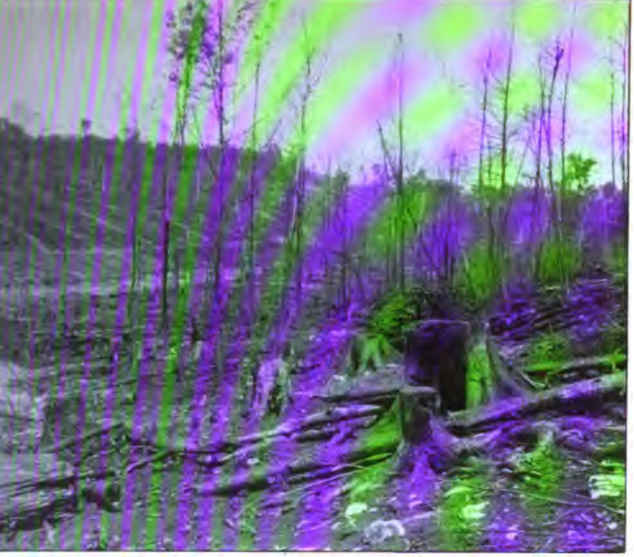
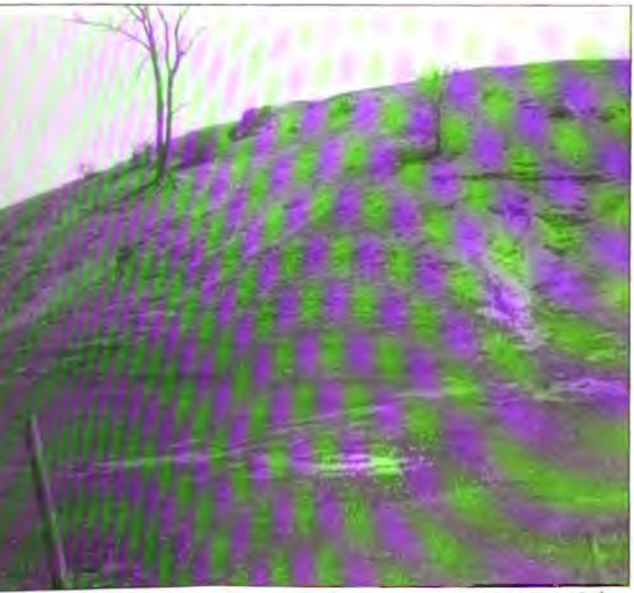


Photo by Hugh P. Baker.

nberman has come and gone and fire has swept over annually rs, the soil formed by centuries of forest cover disappears. enturies to bring the soil back again and make the land as e the forests as when the virgin forest was cleared off.



Courtesy of Conservation Commission.

able forest land in New York that should never have been should this land lie idle for almost a century waiting for n it with forests? While it is idle it is not only unpro- cause of erosion is a menace to agricultural lands below s and rivers.

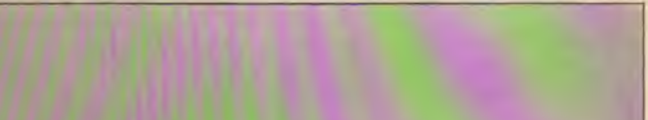
be possible to use methods of natural reproduction that w
unnecessary any large amount of planting. The reforestatio
or barren lands by replanting is expensive and it is hoped
Forestry develops in the State that less and less of it will
sary. The fact that over 3,000,000 acres or nearly 10 per ce
States are covered with no growth of value should be caus
for active agitation and real beginnings in reforestation. T
area of ten per cent of the State should be returning fro
eight millions of dollars annually with only very ordina
management. In the County of Onondaga alone there a
acres of unimproved land and it is very safe to say that ov
of these must be replanted if they are to be made in any
ductive. They will be absolutely nonproductive if left barre
are not adapted to agriculture of any kind.

IDLE LANDS WITHIN FARMS OF THE STATE.

Too much of the real idle land of this State is found
within our farms. There are very few farms which do
from 10 to 40 acres that are better suited for growing timber
any agricultural crop. Often, if these lands are stripped of
growth they will soon begin to wash and at once become
to the more valuable lands lying below them, therefore, when
ber is cut, the land should be replanted at once to forest tr
objection to planting a forest is that it takes considerable tim
trees to become of value. This should have less weight in
sideration of the farmer than it has. It is coming to be r
that thrifty growing trees have a definite value however s
are. We do not expect or want good agricultural land to be
the production of trees, but a few acres of drifting sand
hillside will give a bad impression of the farm as a whole.
pective buyer will be greatly influenced in his valuation of
erty by the barren and unsightly portions, perhaps more
influenced than by the actual amount of fertile land, thus i
seen that a good growth of forests on the idle lands of o
would be of value from an aesthetic standpoint and regard
way of the actual value of the growing stock. With the con
mand for poles and posts and other timbers on the farm, i
possible to draw very early indeed upon the planted timb
return. Then too, many of the farms in the State could be
produce as a bi-product obtained by thinning from the plant

Courtesy of Conservation Commission.

l plantations being put out by the State on State lands. cessary to protect the soil, conserve the water supply and here nature will not restock the ground easily we grow , where we want it, more of it, with a greater value, in a and, all things considered, at less expense.



Courtesy of Conservation Commission.

lanting on State lands in Adirondacks. Instead of paper aspen and pincherry occupying this ground for the next s, we have a uniform stand of thrifty pine with every square Such results can be gotten on idle lands anywhere in the State.

enough Christmas trees annually to more than pay for th
and in a sense pay a considerable part of the cost of the
itself. The same is true of larger bodies of cut-over or
belonging either to the States or to large land owners.
desolate barren condition, they are of no value to anyone
are a disgrace to a State as progressive and prosperous as
of New York. The only way to make them valuable is
forest upon them which in time will produce an annua
timber. Far-sighted business men are beginning to see th
young timber and are buying lands covered with promis
growth and holding them until they have a market value.

IDLE LANDS MADE PRODUCTIVE BY PLANTING OF FOREST T

It is a fair question to ask each farmer in the State and
owner whether he has such idle lands as are described
whether it is not worth while to grow a crop that will
increase the sale value of the property but will annually mak
more and more productive. Trees are the only crop which v
and leave the land in better condition than at the start.

Take for example the case of John Mathers who has
Onondaga County. It contains 20 acres of land in the
rocky hillside that is practically useless for agriculture.
has a slope greater than 10 per cent. and therefore should
been cut-over and left clear in the first place because of
of severe erosion. It has long been a question with Mr.
to what use to make of this barren hillside. As it stands t
a constant expense for taxes besides it depreciates the va
entire farm because of its unsightly appearance. Every
deeper and deeper the gulleys on the hillside and carries
rocks farther down over the cultivated fields. The New
College of Forestry at Syracuse University would like to st
and co-operate with Mr. Mathers by making a plan or givi
tions for planting of this waste area with such rapid gro
greens as the White or Norway Pine or the Norway Sp
Mathers being a practical man will want to know the expen
approximate returns of such a plantation before undertaking

The expense of such a plantation as Mr. Mathers woul
make would consist of the cost of planting, interest on valu
taxes on land and timber all carried at compound interest t
of harvesting. The net returns will be the gross returns les

lands worth $4 per acre, cost of planting $7 per acre per cent., it will result as follows for White Pine:

ation in years.	Gross returns.	Expenses.	Net returns.	Net return per acre and year.
	$40 50	$27 50	$13 00	$0 52
ie)	75 00	37 60	38 40	1 28
	195 00	52 54	142 66	4 07
	262 40	72 20	190 20	4 75
ie)	324 80	108 66	216 20	4 80
	465 00	157 85	307 15	6 14
ie)	505 50	228 05	277 45	5 04
	532 00	315 68	216 32	3 60
ie)	566 00	433 28	132 72	2 04

ll bear careful study as it is taken from a large number e from the growth of planted White Pine under condi- ilar to those existing in the county. What does the t indicates that land of poor quality is capable of pro- returns. Up to 25 or 30 years of age, the diameter is material has to be used for poles or fuel or pulp and he stumpage value is around $6 per thousand feet. on it puts on timber rapidly and the quality of the better. It will bring $8 per thousand feet and yield a he age of 35 to 50 of over $4 per acre per year. At of age it yields the highest return which is $6 per acre n the time the timber has passed 35 years of age until can be cut at any time and will return a greater value the value of the land if used in any other way. It that one can afford to pay somewhat more than $4 an that is now idle and reforest it with every assurance ake a profitable long time investment. Approximately ts as described for the White Pine can be obtained by Pine, Norway Spruce, Western Red Fir and such hard- Ash and Red Oak. These last must be put into some- soils and different locations than the conifers described the results of plantations of these species show that returns can be gotten even on the worst bits of idle ms of the State.

Courtesy of Conservation

Forest conditions on a cut-over and abandoned tract fifty y
self-seeding has been accomplished. Note the variety of specie
which are inferior both in kind and quality. Proper managem
remove the undesirable species and increase by two or three
growth of the right kind of trees.

Courtesy of W

A second growth sprout and seedling woodlot properly thinn
and worthless kinds of trees taken out and the better one
chance to greatly increase their growth.

IPROVEMENT OF WOODLANDS AND FARM WOODLOTS.

at there is already a sort of forest growth on these idle e is, it will pay to handle it properly. Thus far in this been using the accumulation of years of growth with- or future growth. Little or no provision is being made crop. Where a second growth is coming on, too little ng given to it. No forest can be continued permanently ctory reproduction is secured and proper conditions

r woodlot, as timber on the farm is usually called, may at the trees retain their limbs well down towards the g it impossible to produce anything but knotty timber. pen that leaf mold, so necessary to proper conditions of ot decompose properly and grass and weeds and brush and occupy the ground. It is all too often in such lition that reproduction is impossible and then the only be done is to cut off the present growth and start a new e beginning. It may be possible at times to thicken up y underplanting or to change the condition to such an f-seeding will be successful. This natural reproduction e place easily if stock is kept out of the woodlot. No an be expected if land is pastured. The wood lot may at the trees crowd each other so severely that growth the trees do not develop. Eventually a certain number the others continue to maturity. This struggle which ath of many young trees may be lessened in intensity enefit of the woodlot by taking out enough trees so that e left will put on a much larger amount of wood because space and light.

lots are made up of a great variety of species, a large which are of little value and should be removed to give ore valuable sorts. The composition and thus the value woodlot may be greatly improved and increased by out the so-called forest weeds, such as Ironwood, Red od, Juneberry, Hawthorn and others.

ly nearly all of the conditions described above are found every county in the State. Several may be found in forest. Look through woodlot or timberland! Is there der 25 years of age? If not, is it not because you have have allowed surface fires to run through annually?

Photo by

Very barren and waste hillsides in the Karst in Southern
brought back to productive forest conditions through the plar
Nowhere in New York are there more barren hills than the
being so successfully reforested. Climatic conditions are mucl
able in New York than in region shown in above picture.

Photo b

Planted White Pine in Germany on very sandy soil. Tl
result of superior soil or climatic conditions or of an ext
of time, but results from the proper handling of the for
beginning.

e has succeeded in starting in the last 25 years, what will be ition of your woodland in the future? Many thousands of forest land are being culled annually with no thought of the and. Every tree removed makes the stand thinner and allows coming of more grass and brush and of more windfalls. No afford to be without a woodlot upon it both because of the and comfort of it and because the material you can take from lly, makes it well worth while from a financial standpoint.

ees and the method of planting that would be suitable for one forest property may not be applicable at all to the adjoining onditions of soil, slope and general situation vary so much h area to be reforested is in a sense a problem by itself. It en save both time and money not to plant without knowing ly as to the nature of soil and trees best adapted to these

LANTED TO FORESTS OR MAINTAINED AS FORESTS MAY BE EXEMPTED FROM TAXATION.

te Law passed in 1912 provides for exemption from taxes rtain classes of lands which are planted with forest trees or re maintained as permanent woodlots or timber lands. For this Law and information as to the procedure to be followed g forest lands for exemption from or reduction in taxes the Conservation Commission, Albany, New York. It is urged that owners of idle or forested lands throughout the ke advantage of the help offered by this Law which seeks to e some of the unfairness of the older methods of taxing ands and puts them more nearly on the same basis as true ral lands.

New York State College of Forestry at Syracuse University te Institution established and supported for educational work out the entire State. It is ready to co-operate with any land who wishes to begin planting or who is desirous of improving llot or timberland by practical forestry methods. Applications ice and co-operation should be addressed to The New York ollege of Forestry at Syracuse University, Syracuse, New These applications will be placed on file and as rapidly as will be taken up in groups by counties and assigned to the n charge of this work. The only expense connected with the n will be the necessary traveling expenses and maintenance

from the nearest previous inspection. By the system of gr
counties this amounts to very little and would probably nev
five dollars. If the amount of land to be examined is over
and reasonable assurance is given that the plans of manage
be carried out the inspection will be made free of charge. (
land owners in the same neighborhood may unite and by
their combined areas to 300 or more acres have plans ma
cost.

STATE OF NEW YORK

Forest, Fish and Game Commission

AUSTIN,
Commissioner

JOHN B. BURNHAM,
Deputy Commissioner

Walter Mulford

BULLETIN 2

See [illegible] SD144 N7P3

REFORESTING

BY

C. R. PETTIS

Superintendent State Forests

ALBANY
J. B. LYON COMPANY, STATE PRINTERS
1910

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Photo C. R. Pettis

General View Saranac Nursery.

REFORESTING.

INTRODUCTION.

to supply general information in regard to reforesting nphlet "Instructions for Reforesting Land" was pre- large edition was printed and all distributed. This is a d enlargement of the above-named publication, necessi- he continuous demand for information in regard to

purpose of this bulletin to give our citizens definite ormation on how to start a forest. There is combined phlet information relative to securing planting stock, the able kinds to use under different conditions, when to to do the planting and some data as to the results that ected.

REFORESTING.

ing means the establishing of forests on lands formerly t cover. It may be secured either by nature, from wind s, or by man planting small trees or sowing seeds. so slow and erratic that she cannot be depended upon. in planting trees and sowing seeds in the field under nditions clearly indicates that planting is a successful ile broadcast seed sowing is too expensive and uncer- sed generally.

HOW TO SECURE STOCK.

r this purpose may be collected in some localities where ufficient supply, may be purchased or can be grown from

-named source offers but a limited supply, the cost is h and the success of such plantings uncertain, because generally have but few roots, which increases the loss nting.

The purchase of trees for reforesting purposes is difficult there are not at present commercial nurseries growing the kinds of trees in sufficient quantity. The demand bei greater than the supply, high prices have resulted.

The Forestry Department of the State of New York n several large nurseries for the propagation of forest tree and transplants — pine, spruce and other species — for re the public lands and for distribution at a nominal price am owners in this State who may wish to undertake reforestin tions on their own account. The price of these seedli transplants is small, being placed at the bare cost, but va the age of the plant and species.

Any land owner who desires trees for planting land in raise a forest can secure them while there is a supply on making application to this Commission. Blanks will be s request.

These blanks are printed each year and distributed about first, and must be completely filled out and filed in the offic Commission not later than March first of any year in secure trees for planting that spring.

The application blank for 1910 was as follows:

Forest, Fish and Game Commission, Albany, N. Y.:

GENTLEMEN.— The undersigned hereby applies for the number and kinds of trees for planting in the town of ... county of ...., State of New York:

.... White pine transplants, at $...... per 1,00
Saranac Inn, N. Y.

.... White pine seedlings, at $...... per 1,000
Saranac Inn, N. Y.

.... Scotch pine transplants, at $...... per 1,00
Saranac Inn, N. Y.

.... Scotch pine seedlings, at $...... per 1,000
Saranac Inn, N. Y.

.... Bull pine transplants, at $...... per 1,000
Saranac Inn, N. Y.

.... Red pine transplants, $...... per 1,000
Saranac Inn, N. Y.

.... Norway spruce transplants, at $...... per
o. b. Saranac Inn, N. Y.

.. White spruce transplants, at $...... per 1,000 f. o.
Inn, N. Y.
.. Red spruce transplants, at $...... per 1,000 f. o. b.
n, N. Y.
.. Balsam transplants, at $...... per 1,000 f. o. b.
n, N. Y.
.. Black locust seedlings, at $...... per 1,000 f. o. b.
N. Y.

CRIPTION OF LAND TO BE PLANTED.

hy ....
growth ....
rowth ....
use of land.................................
soil...

leration of granting this application for trees at the price undersigned hereby agrees:

y the purchase price of the trees to said Forest, Fish Commission within ten days after the granting of this

the trees hereby applied for shall be used by the under- the sole purpose of reforesting lands within the State of

the said trees shall not be sold, offered for sale, or given e said applicant, or his agents, to any person.

the said trees shall be planted in accordance with instruc- shed by the Forest, Fish and Game Commission.

the applicant shall furnish the Forest, Fish and Game from time to time, when asked for, reports in regard lition of such plantings.

Signed ....
P. O. ....
Express office ....

........., 191..

e noted that this application is a contract made with this n. The first clause calls for payment within ten days rees are granted. This gives us the opportunity to resell hat the applicants do not pay for within that time. The second clause is necessary because the law under which this work is done requires that the trees shall be used for reforesting purposes. No trees will be sold for ornamental planting. The third clause prevents speculation and interference with our work. The fourth clause simply means that applicants should follow the directions given in this pamphlet in regard to planting. The fifth clause asks that reports stating the condition of the plantation be made to this office, when asked for, such information being desirable in order to secure data in regard to the work for the benefit of others.

These trees will be shipped during the month of April and May following.

Parties intending to do a large amount of planting with transplants will find it desirable to purchase seedlings and set them out in a cultivated field garden for one or two years. The demand for transplants (seedlings transplanted for one or two years in the nursery) is so great that we are unable to fill all orders, but by purchasing seedlings and transplanting them at home a planter can have a supply when desired without increased expense. A large saving in transportation will be effected by purchase of seedlings.

If any one desires to establish a nursery to propagate his own trees we will be glad to advise him.* The growing of evergreens, especially the first year, requires experience and is not to be generally recommended if seedlings can be purchased at a reasonable price.

WHEN TO PLANT.

Planting is best done in the spring, as early as possible, so that the trees may secure the benefit of the spring rains and become well rooted before the season's growth takes place. We will ship trees in the spring as early as possible, and they ought to be planted at once.

HOW TO PLANT.

When the trees arrive they should be taken to the planting field immediately and unpacked. The roots should be dipped in water and the plants "heeled in;" *i. e.*, placed upright in a ditch, and the dirt packed tight around the roots. (See illustration.) They can be kept in this manner while the planting is in progress.

---

* Detailed information in regard to this work will be found in Bulletin 76, U. S. Forest Service, which can be secured of Superintendent of Public Documents, Washington, D. C., for ten cents.

Trees Heeled In — A Safe Way to Keep Them a Few Days Until They Can Be Planted

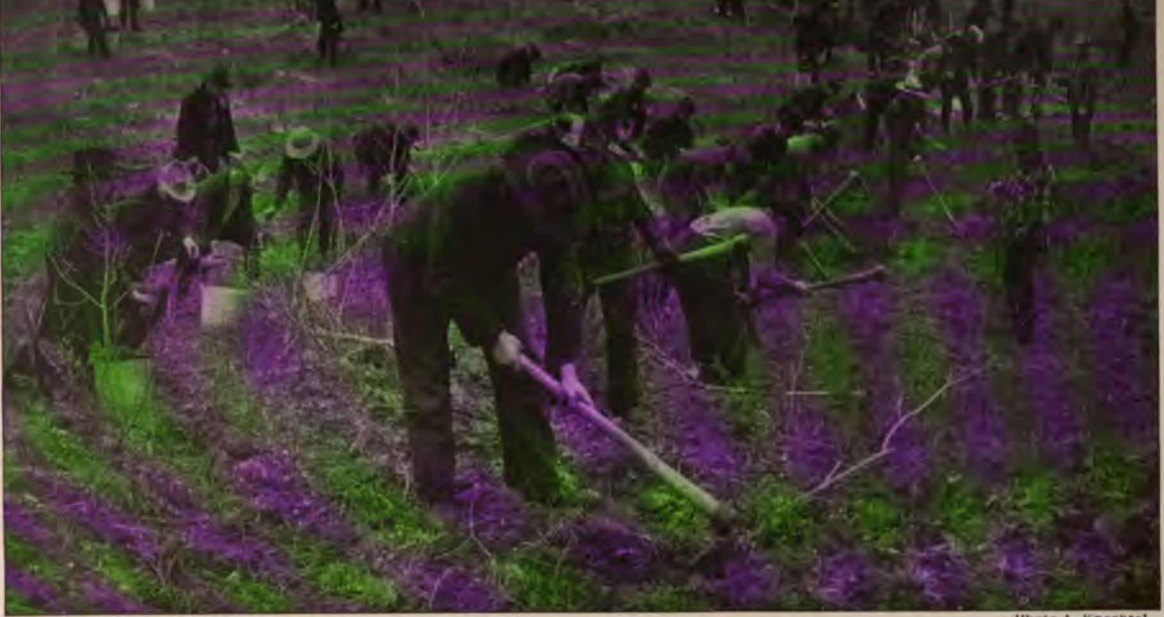

Photo A. Knechtel

Reforesting operations on waste land in the Adirondacks. Mattock men in the first row, planters in second row. The pails are used for carrying the little seedling trees.

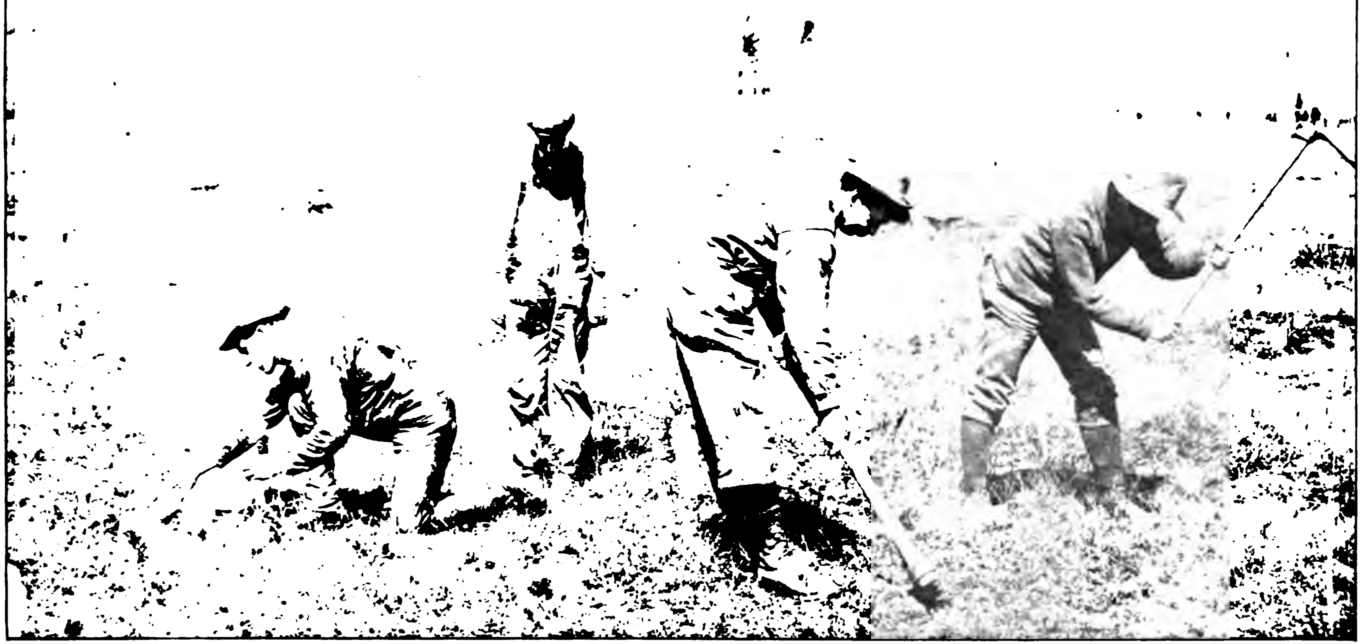

Photo A. Knechtel

The Four Steps in Planting a Tree.

er of men required and the organization of the force entirely upon the amount of planting to be done. In ons we will assume that only a small number of trees out, *i. e.*, not over 10,000 plants. For larger operations ust be increased.

ing unit is two men, one of them equipped with a grub other with a pail for carrying the little plants. Two ng thus as a pair — one making the hole and the other e tree — will, after a little experience, set out about plants or 1,200 per day. If only a few thousand trees planted two men can do the work within the required f many thousand, several pairs of men will be necessary. ting site having been selected, the men with the grub egin making the holes in a straight line across the field. o set up a stake, or two, in order that the man digging move forward in a straight line. These stakes or poles ved over and used again when making the next row of e planter follows immediately behind the grub-hoe man tree in each hole before the exposed soil becomes dry. er's pail should always have enough muddy water in the keep the tree roots wet.

ing a hole, it is well to cut off and remove a thin slice of is gives the plant a better opportunity to grow. The hole large enough to give room for the roots without crowd- n a light soil the least dirt that is moved in order to set properly the better it will be. The plant should usually in the ground at the same depth that it was before; but sandy soil it may be set slightly deeper. The earth should about the roots thoroughly, so that the plant will be able the moisture possible from the surrounding earth. Care taken also to place the roots in their natural position. pains should be taken to prevent any exposure of the the sun. Once they become dry the plants are very likely The trees "heeled in" should be kept moist at roots. en continue planting back and forth across the field until is completed. The trees planted in these rows should be gular distances apart and the rows also at even distances to properly utilize the soil and light and to secure, in time, est product. The spacing varies under different conditions, general forest planting six feet apart both ways is most . When the trees are planted six feet apart in the row, rows are made six feet distant, it will require 1,200 trees

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Photo C. R. Pettis

Planting a Tree.

WHAT TO PLANT.

to have the plantation successful and produce a profit- ient, there are certain factors which must be considered. nainly light, soil mosture and soil fertility. These re- must be considered in the selection of trees for planting. have much greater demands both on light and upon soil .

GENERAL CONDITIONS.

es are quite exacting in regard to necessary fertility. ire best adapted to light sandy soils with but little fer- the spruce, yellow poplar and catalpa require good

SOIL MOISTURE.

unt of moisture required by trees depends upon their . Such trees as the Scotch, Austrian and red pines, also and red oak, make satisfactory growths upon dry soils ir long tap roots are able to take up moisture from the oil. No trees require or can make a satisfactory growth s thoroughly saturated with water as air in the soil is

LIGHT.

in order to make a profitable growth require light. s, such as spruce, have the ability to withstand shade, eneficial to nearly all of them when they are small. In cure the most satisfactory growth a tree must have its rements satisfied. The existing growth, be it grass, rush, mature trees, or other vegetation, and the density it stands (therefore, the amount of shade it produces or, rds, the scarcity of light which results and lack of light nted tree) is a very important factor in determining not kind of a tree should be planted under these conditions or size of tree.

lication of this nature covering such a large subject, no irections can be given. A careful study of these pages able the planter to determine the kind and size to use.

Whenever pasture or other lands of but little shad planted with pine the two-year old seedlings are suffic In planting spruce only transplants should be used. ing under heavy shade only transplants should be used shade is dense the species which endure shade are m to use.

SPECIES.

White Pine.— This species is usually found on sa soils, but it will do well on any land that is well drai thrive in good soil as well as any other tree when once The better the soil, the faster its growth will be. Th our most valuable timber trees and adapted to a wide ra It should not be used on the light, sterile sandy soi not retain a vegetable covering, nor should it be us clay soil or in places where the soil is saturated with w ject to serious flowing for a long period. It can be u soils that have the ability to maintain fibrous coverings

Scotch Pine.— On the poorest sterile soils the Scotc more desirable for use than is the white pine. It is adapted for this purpose because it has a long tap roo deep into the soil and is not affected by drying out of soil. The lumber produced from this tree is not as val of white pine, but the greater growth that it is able to very poorest sterile soils ought to offset the difference

Red Pine.— The red, or Norway pine, is a native State. It is very desirable for use on coarse, gravelly lumber is not as valuable as white pine, the wood being it is better than that from Scotch pine.

Bull Pine.— This is the yellow pine of the wester in the Black Hills of the Dakotas, makes a very fin young trees are very vigorous and are adapted to the and should be used the same as Scotch pine.

Norway Spruce.— This is a German tree which ha duced and generally planted in the northeastern state results. It is perfectly hardy in this State and should forestry purposes in preference to our native or Adiro This spruce is the one generally used abroad. It shoul practically all cases in this State wherever spruce is p spruces have a flat root system and are, therefore, ad on shallow soils if other requirements are satisfied. I

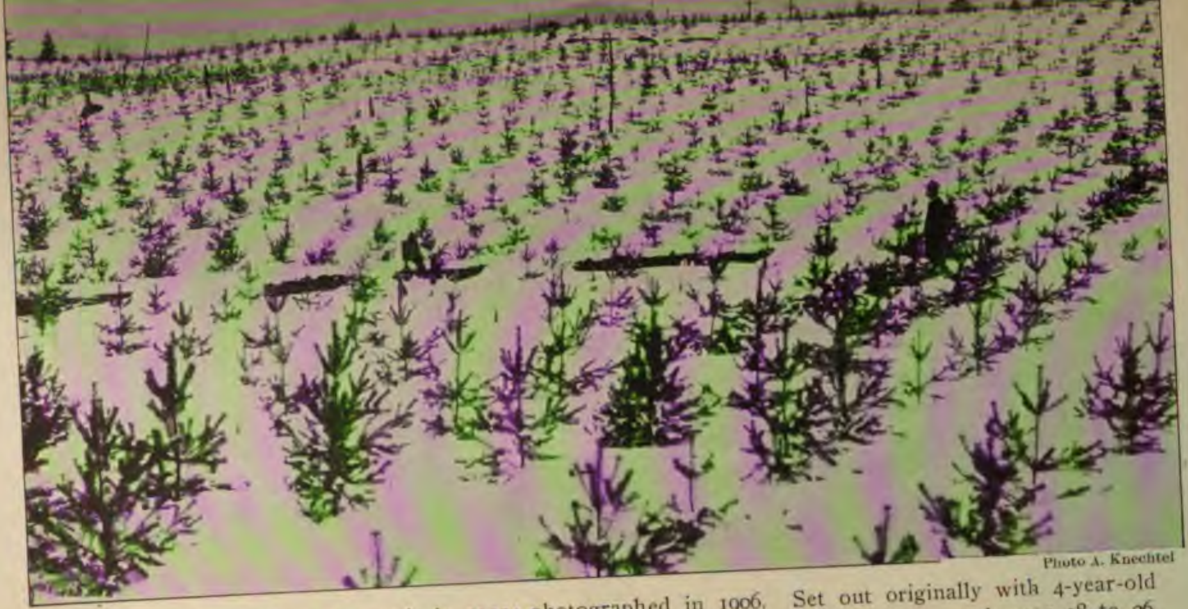


Photo A. Knechtel

Plantation of 650 acres made in 1902; photographed in 1906. Set out originally with 4-year-old transplants 10 to 14 inches high; trees now 6 feet high and making leaders each year 18 to 26 inches long. Trees planted at 5-foot intervals and all alive. The area included in this photograph is planted with Scotch pine.

Photo C. R. Pettis

Scotch Pine Plantation Six Years after Planting — (Same plantation as shown on preceding page).

e have for use on swampy or wet locations. In order to
lesirable growth it should not be planted on sand or light
the latter part of this pamphlet will be found some figures
growth of this species and its value as a crop. It is desir-
underplanting and use under heavy shade.

pruce.— This is the native Adirondack species, and even
experience with it in plantations indicates that it has no
not found in the Norway spruce, and grows much slower.
a slow grower that its use is not recommended.

.— Should be used only in exceptional cases. The Norway
a far better tree for situations where balsam would be

an Larch.— This is a true mountain tree of Central
and when planted in this country has, usually, made a
th. The wood is very durable and strong. It is not like our
rch (the tamarack) a tree of the swamps, yet it requires
airly porous, and moderately fresh soil. It should not be
he poor or sandy soils. The season's growth often begins
e frost is out of the ground and, therefore, it should not
where the danger from late spring frosts is great. It is a
wer, but demands a large amount of light. It is best used
re with spruce, pine, or some of our hardwoods. It can
pure plantations if it is desired to underplant when the
about twenty-five (25) years old.

HARDWOODS.

ne cases and for special purposes the owner may desire to
rdwood rather than coniferous trees. In order to assist
ties, we are growing red oak, white ash, basswood, yellow
nd black locust.

ak.— This tree grows best on a porous soil either with a
gravelly tendency. The soil should always be well drained.
never be shaded except for the first two or three years.
most rapid growing oak and is a desirable tree to plant
rly favorable conditions. It is valuable not only as lumber,
ich used for posts, poles and ties.

Ash.— Is a desirable tree for planting in this State out-
ne Adirondacks on moist soils of fairly good quality. The
first few years, will withstand heavy shade, but when
d should have full light. It is a rapid grower and the
of great value.

Basswood.—This species is suitable for planting o soils, moist but well drained. It will withstand a mode of shade, but when it becomes fully established shoul cient light. Its rate of growth is comparatively ra material of much value. It is not suited for plan Adirondacks.

Tulip or Yellow Poplar.—This tree is very exactin requirements. In order to make a satisfactory growth a deep, fertile, well drained soil and a constant even m ply. It requires a large amount of light. It is one valuable timber trees, but the planting sites should selected. The lumber is nearly as valuable as white pi its demands are satisfied is a very fast grower.

Black Locust.—This is the common locust and als yellow locust. This tree is not adapted to planting in th of the State where the danger of a heavy frost is lia before the season's wood growth hardens. It will growth on any soil that is not wet, and as a rule it sh planted on the better soils unless the frost danger is s quires a large amount of light. It is relatively a shor liable to injury from wood borers and its chief value li of its wood for posts.

Catalpa.—The catalpa has been extensively recom advertised as a tree for forest planting. Its use in limited and cannot be recommended for forestry purp in the "fuit belt." In the purchase of this stock car taken to secure the *hardy catalpa* (*Catalpa Speciosa.*) sitive to early frosts and should be planted only in portions of the State.

Black Walnut.—This tree has been planted in some a large scale. The high price of lumber from this tr the very dark color of the heart wood which is secure old trees. It is a fast growing tree with but little soil except a reasonable amount of moisture. It can be grown throughout the State except in the mountain undoubtedly other trees can be planted to produce a crop in less time and with a larger profit on the invest

Carolina Poplar.—This tree is suitable for planting the State on any but the poorest soils. It is a very r but requires a large amount of light. It is recommende ing where quick returns are desired and the crop can b the manufacture of paper or excelsior.

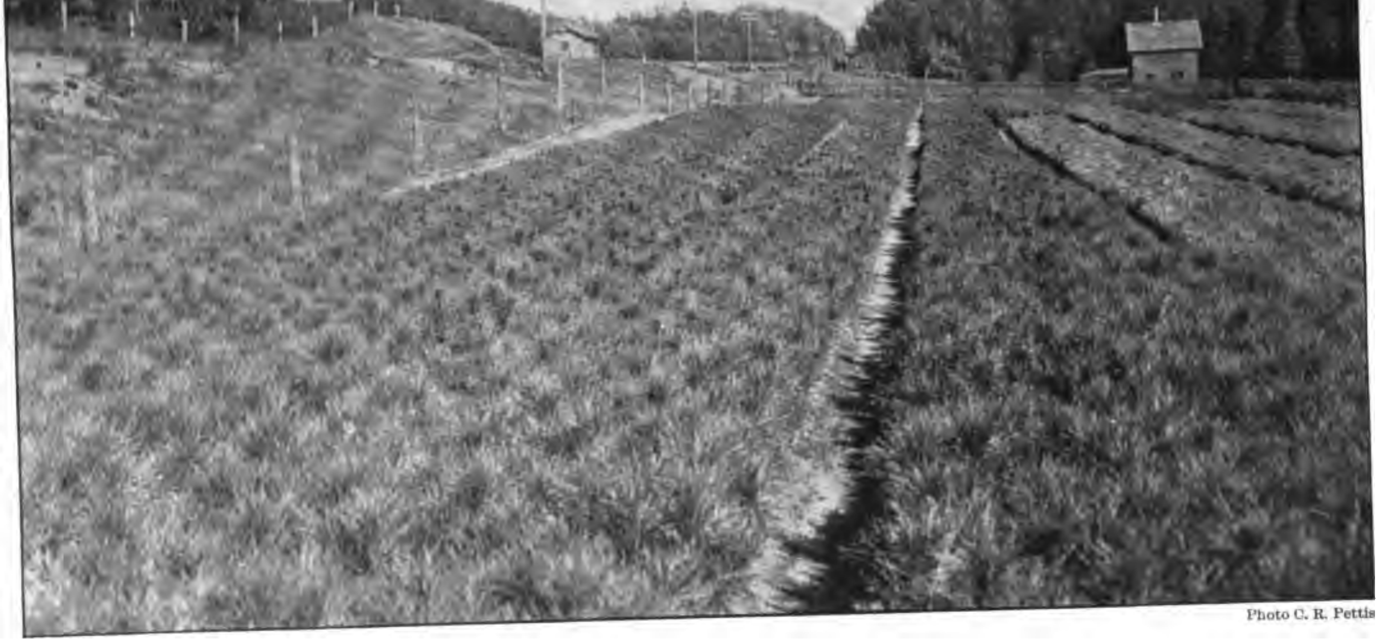


Photo C. R. Pettis

Transplants in Nursery.

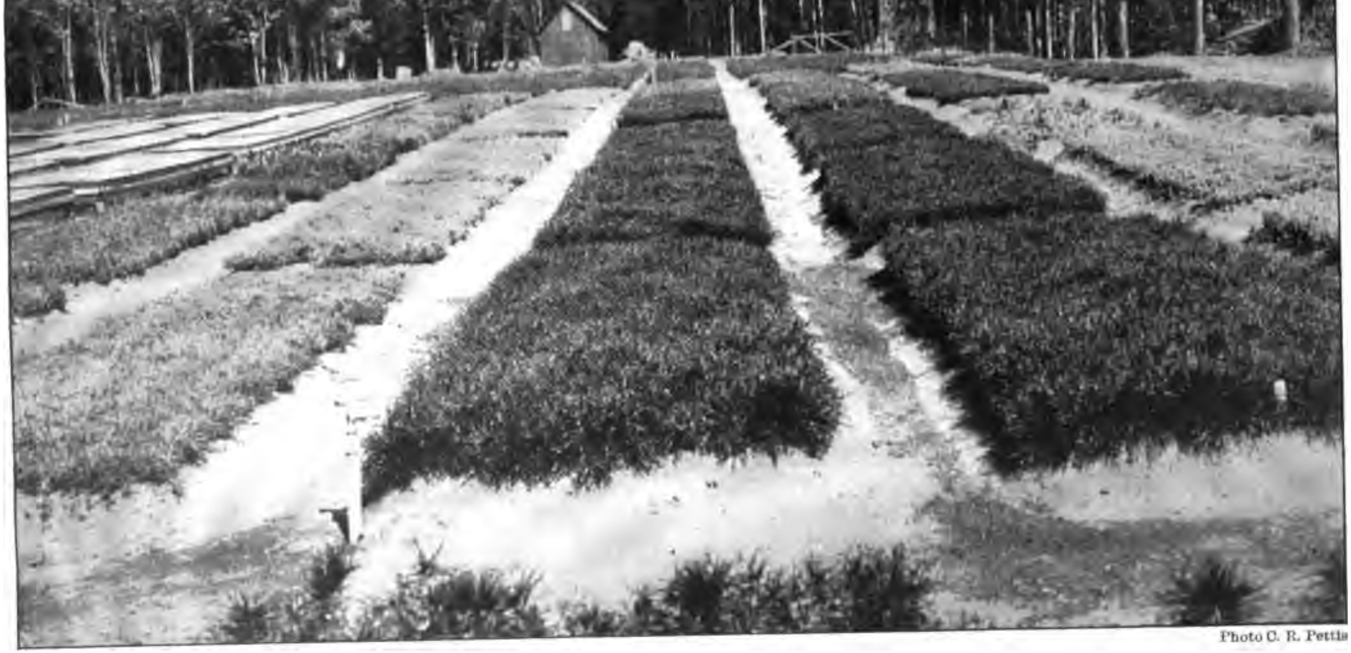


Photo C. R. Pettis

Two-year Seedlings in Seed Beds.

Photo C. R. Pettis

White Pine Plantation Six Years After Planting.

CONSIDERATIONS IN DETERMINING SPECIES TO USE UNDER DIFFERENT CONDITIONS.*

SPECIES.	Range of planting	Quality of soil suitable	Soil moisture requirements.	Demand for light	Soil depth required.
White pine	Entire State	Except poorest	Medium dry	Moderate	Medium.
Scotch pine	Except along the coast	Poorest	Dry	Large	Deep.
Red pine	Entire State	Especially gravelly	Dry	Medium	Deep.
Bull pine	Entire State	Poorest	Dry	Medium	Deep.
Norway spruce	Entire State	Not sandy	Fresh	Small	Shallow.
Red spruce	Mountain sections	Not sandy	Fresh	Small	Shallow.
Balsam	Mountain sections	Not sandy	Fresh	Least	Shallow.
European larch	Except mountain sections	Not sandy	Fresh	Much	Medium.
Red oak	Except mountain sections	Except poorest	Well drained	Large	Deep.
White ash	Except mountain sections	Fair	Fresh	Large	Medium.
Basswood	Except mountain sections	Fertile	Moist	Medium	Deep.
Yellow poplar	Warmer portions	Rich	Moist	Large	Deep.
Black locust	Except mountain sections	Except poorest	Dry	Large	Medium.
Catalpa	Fruit belt	Rich	Fresh	Large	Deep.
Black walnut	Except mountain sections	Except poorest	Dry	Large	Deep.
Carolina poplar	Entire State	Poorest	Dry	Large	Medium.

* These are minimum requirements. Any tree will grow best on deep, rich, moist soil, with full light, in moderate temperatures.

Chestnut.— This was one of our most promising account of the appearance and very rapid spread of blight" a most virulent and destructive disease, it recommended until some means of controlling the found.

YIELD FROM PLANTED FORES

In the destruction of forests by axe and fire w taking place in this country ever since settlement beg not adapted to agricultural purposes have been clea farms, tilled for a time, the soil exhausted and the These areas are of varying size, but in the aggregate In some places they include a few acres of an occu others they embrace entire abandoned farms. This idle, is not producing any revenue for its owner; in f a loss because taxes must be paid, and the interest invested is lost. A large area of such idle land in an as serious an economic proposition as idle labor, bec non-productive.

Such land should be planted with small trees in forest crops and reap a future profit. The resultin also make the country more beautiful, more habitable ful and more enjoyable. These forests will protect from erosion, prevent the floods which carry down deb tate the low lands, and will make the water in the equable in its flow. These streams rendered cooler will support more fish, and the forest cover will also a for birds and game. We can secure all of these bene same time realize a large profit from these idle land placed under wood crops.

Natural grown forests are not the most valuable, b does not utilize the light and moisture to the best a by properly spacing the tree, as done in an artificial and better trees can be grown in a shorter period.

We have not many planted forests in this countr to give complete information of what can be expecte Therefore, we have to use natural growth in determin from prospective wood crops. The quantity produce average, be less than what would be obtained from pl therefore, these figures are conservative.

We have not yet had time to secure data in regard of white pine in this State, but careful examinations

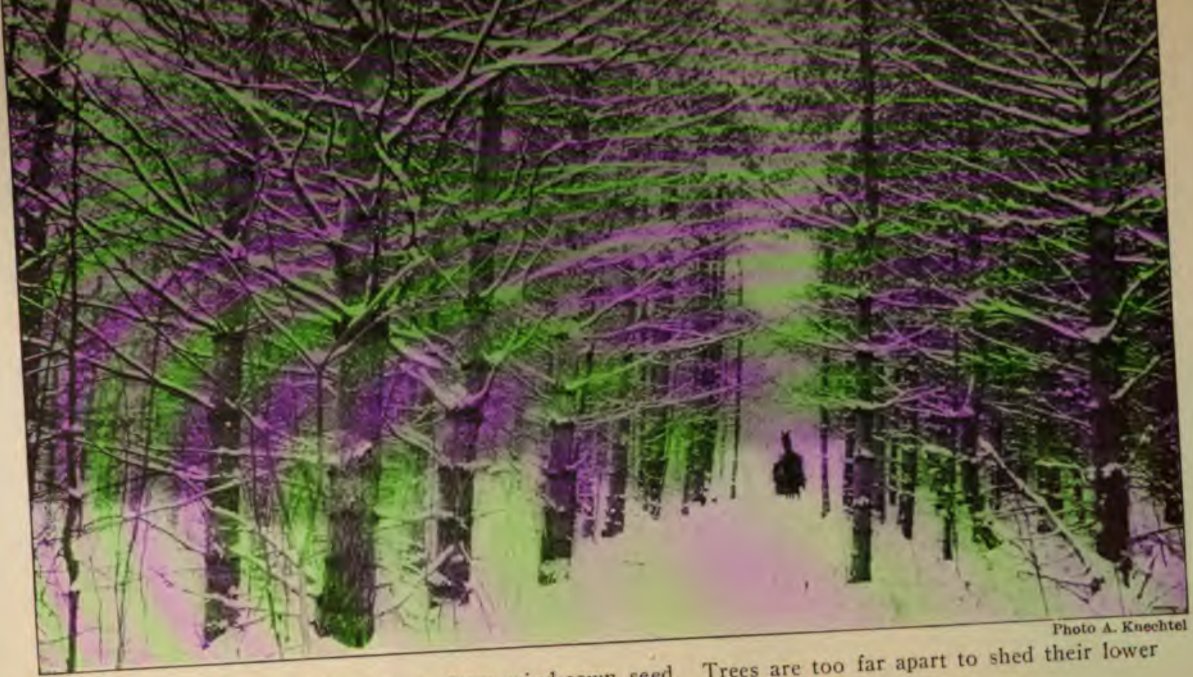


Photo A. Knechtel

Second growth white pine grown from wind-sown seed. Trees are too far apart to shed their lower branches naturally.

ients have been made in New Hampshire and Massachusetts which re just as reliable as a basis for computing future growths in New 'ork as in those states.

The following yield table for white pine was constructed after xamining and measuring 177 sample plats in Massachusetts of arious ages in all parts of that State:

YIELD TABLE FOR WHITE PINE.*

AGE (YEARS).	SOIL QUALITY I.	SOIL QUALITY II.	SOIL QUALITY III.
	1-in. boards.	1-in. boards.	1-in. boards.
	Ft. B. M.	Ft. B. M.	Ft. B. M.
	10,825	6,750	3,975
	19,900	12,500	7,500
	31,150	24,400	16,950
	40,650	32,800	25,200
	49,350	40,600	32,100
	55,150	46,500	37,550
	59,650	50,550	42,100
	63,600	53,200	44,550
	67,050	56,600	46,150

* After Harold O. Cook, under the direction of F. W. Rane, State Forester of Massachu- ts.

This table indicates at a glance that much more than timber can grown in the same period of time on good soil than on poor soil. ie highest production was found on the rich lowlands, where the il was deep, rich and moist, but withal well drained. The upland sture, our hillsides and upland plateaus, which form the largest rt of land where wood crops will be planted, is indicated by soil ality two. The rate of growth here is not far below that of soil ality one, because the pine finds its demands as regards moisture, d supply, etc., well supplied. The third quality of soil consists the wet, cold, mucky swamps, or the most sterile drifting sands. r the purpose of this publication soil of the second quality will considered, because this is the kind of soil that will most largely used for growing forest, raising crops of timber and wood terials.

The table shows in a most striking manner how the quantity of ber increases with the age of the forest. It, therefore, shows at a short-sighted policy and poor financial plan it is to cut wing forests. It will be seen that a forest thirty years old con- is nearly twice as much lumber as one twenty-five years of age, a thirty-five year old crop three and one-half times as great as en harvested at twenty-five years; also, that while it takes enty-five years to grow the first 6,750 feet of lumber, nearly

40,000 feet more can be grown in a second twenty-five allowing the crop to grow fifty years.

The land owner is also interested in knowing wha pect in the way of financial returns as well as quantit For this purpose the following interesting tables, wh pared by the State Forest Service of Massachusetts, published with the permission of Frank Wm. Rane, S of Massachusetts:

MONEY YIELD TABLE.

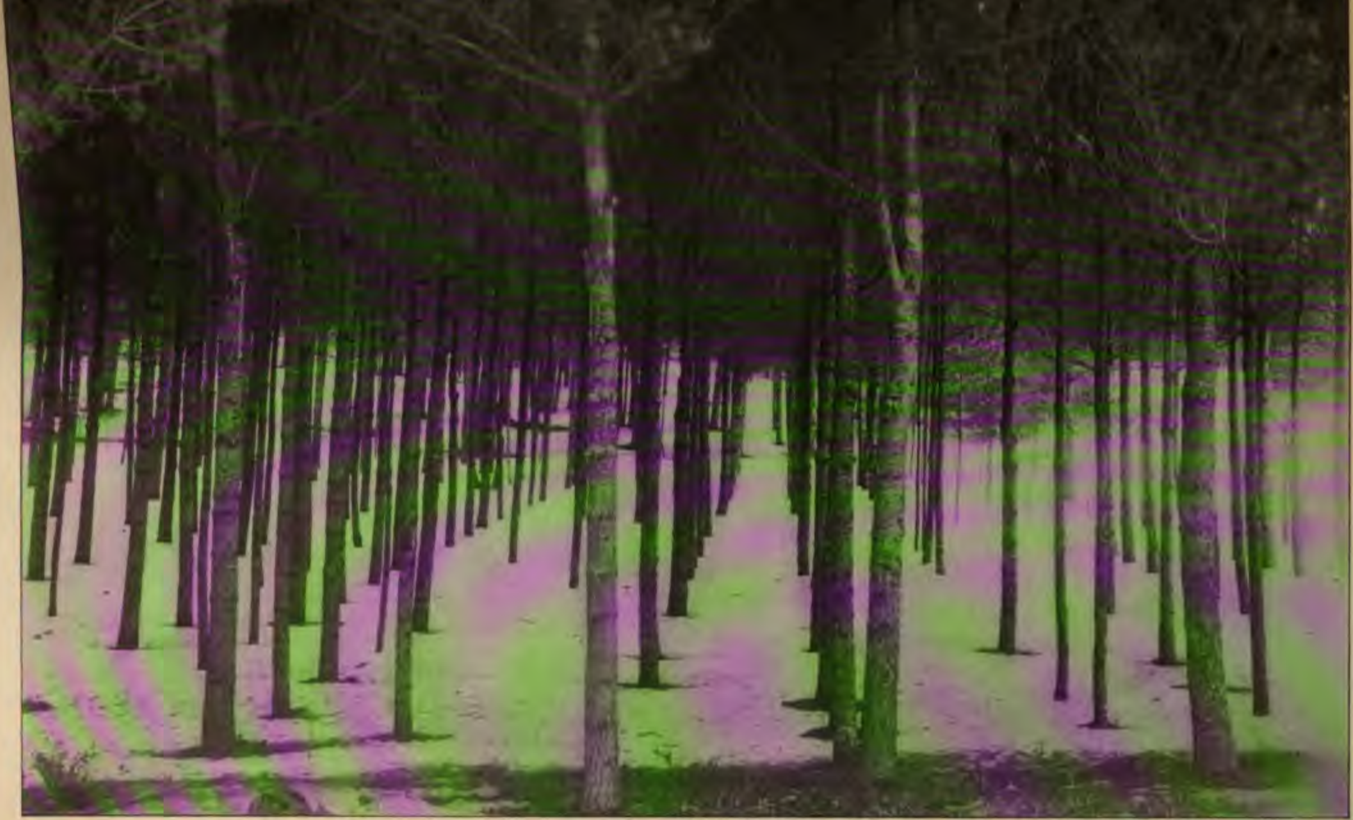
STUMPAGE VALUES.

AGE (years).	QUALITY I.			QUALITY II.			
	Volume.	Per M. Ft.	Stumpage.	Volume.	Per M. Ft.	Stumpage.	Volume
	Bd. ft.			*Bd. ft.*			*Bd. ft.*
25......	10,825	$6 00	$65 00	6,750	$6 00	$40 50	3,975
30......	19,900		119 40	12,500		75 00	7,500
35......	31,150	$8 00	249 20	24,400	$8 00	195 20	16,950
40......	40,650		325 20	32,800		262 40	25,200
45......	49,350		394 80	40,600		324 80	32,100
50......	55,150	$10 00	551 50	46,500	$10 00	465 00	37,550
55......	59,650		596 50	50,550		505 50	42,100
60......	63,600	$12 00	763 20	53,200		532 00	44,550
65......	67,050		804 50	56,600		566 00	46,150

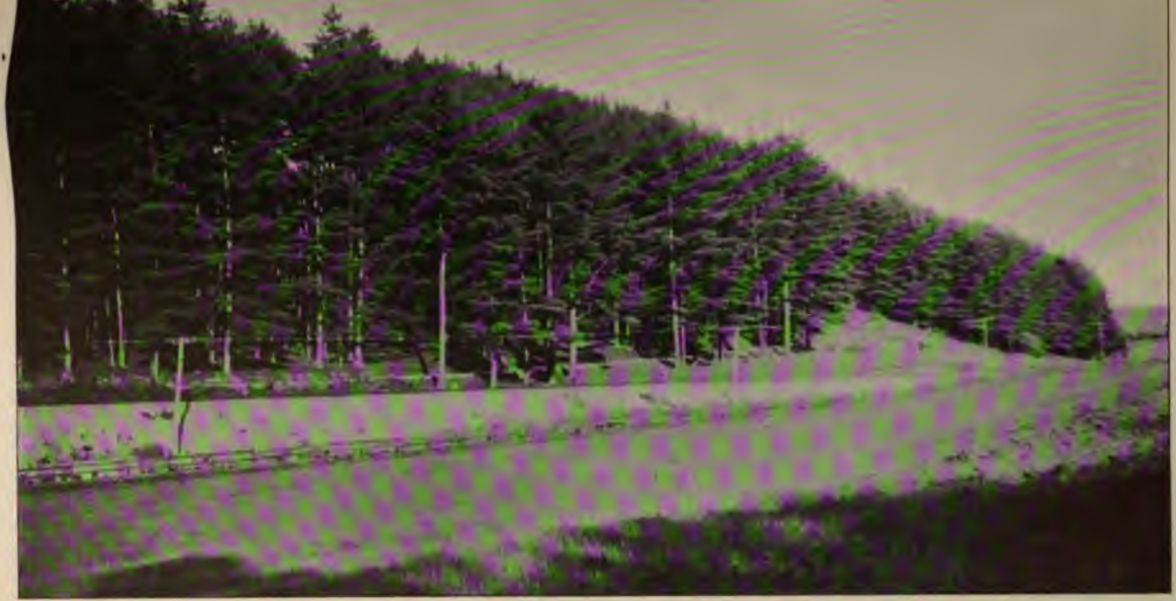
FINANCIAL ROTATION OF WHITE PINE,

Money at 4 per cent.; value of land, $4 per acre; cost of planting,

ROTATION (years).	Gross returns stumpage value.	EXPENSES.			
		TAXES.		COST OF PRODUCING.	
		Taxes on timber accrued to end of rotation.	Taxes on land accrued to end of rotation.	Interest on value of land accrued.	Cost of planting carried to end of rotation.
25..............	$40 50	....	$2 17	$6 66	$18 66
30..............	75 00	$3 03	2 90	8 97	22 70
35..............	195 20	9 32	3 82	11 78	27 62
40..............	262 40	18 47	4 92	15 20	33 61
45..............	324 80	42 16	6 25	19 36	40 89
50..............	465 00	75 76	7 90	24 43	49 75
55..............	505 50	127 04	9 90	30 58	60 52
60..............	532 00	192 60	11 35	38 08	73 64
65..............	506 00	281 32	15 18	47 20	89 60



Plantation of White Pines, Made in 1885, by Mr. Charles H. Faxon, on His Land near Chestertown, Warren Co., N. Y.



White Pine Grove — Saranac Lake Village. Long Clean Trunks Due to Density of Stand.

per cent.; value of land, $4 per acre; cost of planting, $7 per acre.

Gross eturns tumpage value.	Expenses.					Net profits.
	TAXES.		COST OF PRODUCING.			
	Taxes on timber accrued to end of rotation.	Taxes on land accrued to end of rotation.	Interest on value of land accrued.	Cost of planting carried to end of rotation.	Total ex-penses.	
$40 50	....	$2 50	$9 54	$23 70	$35 75	$4 75
75 00	$3 13	3 48	13 30	30 25	50 15	24 85
195 20	9 80	4 73	18 06	38 61	71 20	124 00
262 40	19 85	6 54	24 16	49 28	99 83	162 57
324 80	45 60	8 37	31 94	62 90	148 82	175 98
465 00	83 36	10 99	41 87	80 27	216 50	248 50
505 50	142 37	14 30	54 54	102 45	313 66	191 84
532 00	220 82	18 55	71 70	130 75	441 83	90 17
566 00	331 40	23 97	91 35	166 88	613 60	*—47 50

ans a loss; the investment bringing less than 6 per cent. interest return.

per cent.; value of land, $4 per acre; cost of planting, $7 per acre.

Gross returns stumpage value.	Expenses.					Net profits.
	TAXES.		COST OF PRODUCING.			
	Taxes on timber accrued to end of rotation.	Taxes on land accrued to end of rotation.	Interest on value of land accrued.	Cost of planting carried to end of rotation.	Total ex-penses.	
$40 50	....	$2 90	$17 17	$30 04	$50 10	*—$9 61
75 00	$3 21	4 18	22 97	40 20	70 56	—4 44
195 20	10 28	5 90	30 72	53 80	100 69	94 51
262 40	21 30	8 20	45 14	72 00	146 64	115 76
324 80	49 48	11 26	55 06	96 35	212 15	112 65
465 00	89 04	15 37	73 68	128 94	307 03	151 97
505 50	160 30	20 87	98 60	172 55	452 32	53 18
532 00	255 23	28 23	131 94	230 90	646 30	—114 30
566 00	390 52	38 08	176 56	308 98	914 14	—348 14

eans a loss; the investment bringing less than 6 per cent. interest return.

pruce.— A plantation of Norway spruce made on the
te at Woodstock, Vermont, shows a large profit. The
et eight feet apart each way, requiring 680 trees per
oil was poor sandy hillside. In 1908, or thirty-two
lanting the three-year-old transplants, four trees were
neasurements were as follows:

—72 feet high, 11-inch butt cut, 46½ feet of logs 6″ at top end
—57 feet high, 15-inch butt cut, 47½ feet of logs 6″ at top end
—63 feet high, 14-inch butt cut, 42 feet of logs 6″ at top end
—67 feet high, 16-inch butt cut, 40 feet of logs 6″ at top end

examination of the plantation shows that it has on the
luced about one and one-half cords per acre per year,
tainly an excellent return on the money invested.
ood cut here was sold to the International Paper Com-
nade it into paper at the Bellows Falls mill. Mr.

Edward Barrett, superintendent of this mill, reports as follows: "The Norway spruce test: One cord of rough wood, 71 sticks 4 feet long, after preparing for grinder room, gave us 98 cubic feet. This made 1,828 pounds of dry woodpulp. The spruce worked nicely on the paper machine, and under the same conditions as our regular spruce gave us a higher test for strength and a brighter shade with the same amount of color."

With the decreased supply coupled with increased demand higher prices for lumber and wood products will result. Planting a forest crop on our poor worn out or abandoned lands is an excellent investment and there is nothing difficult in the operation.

PROTECTION.

Naturally every investment is attended with some risk, but in case of forest properties the owner must care for his own property and to a very large extent his own policy determines its safety. In reforesting there are but four risks to be considered. They are injury from domestic animals, forest fire, insect pests and plant disease.

Cattle.— There is but little use in attempting reforesting unless the plantation is to be protected. In any case all domestic animals must be excluded after planting. They not only stamp down and injure the small trees but often eat them off, producing stunted or deformed trees.

Fire.— This is the worst enemy of young trees. A plantation, or in fact any forest growth, should always be protected from this danger.

Insect Pests.— They are of but little consequence in connection with the trees considered in this publication except the black locust. The locust is attacked by borers in some parts of this State and is, therefore, only a short-lived tree. In case of any insect troubles correspond with the State Entomologist, Albany, N. Y.

Plant Diseases.— These, except the white pine blister rust, fortunately are not sufficiently common in this country to be seriously considered. The use of imported trees in reforesting should not be considered. They may be, apparently, purchased for a less price, but on account of the many and very serious diseases on forest trees abroad, they should not be used. Their importation into this State is prohibited except after inspection by agents of the Department of Agriculture, Albany, N. Y.

The white pine blister rust is so serious that imported white pine should not be used under any circumstances.

e chestnut blight is so virulent that when a tree is affected it
re to die. There is no known remedy for this disease. The
ient of chestnut trees from eastern States or from eastern
York into other parts of the State is quite likely to carry the
se. Chestnut should not be brought from the localities on
ccount.

REFORESTING IN THIS STATE.

foresting has been going on in this State several years, but it
ficult to determine all that has been accomplished.

veral large land owners have their own nurseries and are re-
ting on a large scale. In 1909 this Department tried to secure
mation on this subject but was unable to secure complete data.
however, certain that private land owners have planted about
acres in the last ten years on their lands, and this Commis-
has planted nearly as much more State land. The difficulty
private planting in the past has been to secure the necessary
which we hope will soon be overcome by either State or com-
ial nurseries being able to fill the demand with good material
reasonable price.

ie demand for trees last spring (1910) was far greater than
supply. The result of this year's planting has not yet been com-
l, but the summary for 1909 was as follows:

Summary of 1909 Tree Distribution*

Application number	COUNTY WHERE PLANTED	Total trees planted	Acres planted	Per cent. living	Cost of planting per acre, including trees	Opinion of reforesting	Estimated acres of land in town that ought to be planted
1	Franklin	4,000	4	90	$6 50	Favorable	100
2	Fulton	20,000	29	95	......	Excellent	....
3	Wyoming	10,000	......	....	......	....	....
4	Otsego	100	......	80	......	Favorable	1,000
5	Essex	10,000	11	95	8 75	Excellent	....
6	Essex	10,000	11	95	8 75	Excellent	....
7	Hamilton	2,000	2	98	10 00	Excellent	3,000
8	Fulton	10,000	12	90	8 00	Excellent	½ of town
9	Sullivan	3,000	2½	90	8 00	Excellent	25 to 50%
10	Nassau	61,500	......	....	......	....	....
11	Hamilton	10,000	4	95	8 00	Excellent	2,000
12	Westchester	4,000	......	....	......	....	....
13	Oneida	1,000	1	98	12 00	Excellent	....
14	Oswego	3,000	3	98	7 50	Excellent	500
15	Oswego	170,700	160	85	14 00	Excellent	25%
16	Essex	10,000	11	95	8 75	Excellent	....
17	Chautauqua	700	1	95	7 00	Excellent	10%
18	Fulton	2,000	2	100	13 00	Good	75%
19	Westchester	2,000	3	90	......	....	....
20	Oneida	4,000	......	95	......	....	10,000
21	Chattaraugus	1,000	1	98	7 00	Favorable	....
22	St. Lawrence	45,000	......	....	......	....	....
23	Oneida	1,000	1	99	15 00	Favorable	1,000
24	Westchester	2,000	2	99	......	Favorable	....
25	Ontario	3,000	2½	90	12 00	Excellent	2,000
26	Clinton	5,000	6	80	7 00	Excellent	1,000
27	Oneida	500	1½	50	10 00	Necessity	10%
28	Albany	2,000	1	85	14 50	Necessity	4,000
29	Albany	2,000	2	95	7 00	Favorable	....
30	Rockland	2,000	1½	98	10 00	Favorable	....
31	Albany	4,000	10	98	3 00	Favorable	....
32	Oneida	2,400	......	....	......	....	....
33	Otsego	60,000	50	98	10 80	Favorable	4,000
34	Madison	1,250	2	95	7 50	Favorable	100
35	Herkimer	100	......	96	......	....	2,000
36	Suffolk	1,000	......	75	......	....	....
37	Herkimer†	....	......	....	......	....	....
38	Oneida	1,000	1	98	6 00	....	....
39	Otsego	3,000	4½	98	6 00	....	100
40	Herkimer	2,000	2	98	10 00	....	500
41	Oneida	2,000	......	....	......	....	....
42	Orange	3,000	2½	70	......	Favorable	....
43	St. Lawrence	2,000	2	95	12 00	Favorable	1,000
44	Cattaraugus†	....	......	....	......	....	....
45	Franklin	1,000	......	....	......	....	....
46	Rockland†	....	......	....	......	....	....
47	Ulster	2,000	1½	98	15 00	Necessary	....
48	Oneida	3,000	4	97	12 00	Desirable	....
49	Franklin	2,000	2	98	8 00	Favorable	50%
50	Greene	1,000	1	60	8 00	....	....
51	St. Lawrence‡	....	......	....	......	....	....
52	Albany	1,500	2	90	......	....	....
53	Suffolk	2,000	3	70	9 00	Very good	....
54	St. Lawrence	7,000	8	97	10 00	Necessary	....
55	Seneca	1,500	......	....	......	....	....
56	Westchester	3,000	3	70	......	Favorable	....
57	Oswego	11,000	10	90	10 00	Favorable	....
58	Hamilton	10,000	6	99	16 00	Profitable	2,000
59	Washington	5,000	5	90	10 00	Necessity	1,000
60	Orange	100	......	....	......	....	....
61	Essex	32,000	25	90	11 00	Necessity	4,000
62	Cattaraugus	80	......	90	......	....	....
63	Montgomery	1,000	1	90	10 35	Desirable	Large.
64	Delaware	2,100	1¾	90	8 25	Desirable	....
65	Schenectady	1,000	......	....	......	....	....
66	Delaware	2,000	1½	85	12 00	Desirable	1,500
67	Fulton	1,000	⅜	98	9 00	Profitable	1,000

*Wherever blanks appear no report had been received when report was prepared.

† Canceled at applicant's request.

‡ Cancelled for non-payment.

Summary of 1909 Tree Distribution*—(Continued).

COUNTY WHERE PLANTED	Total trees planted	Acres planted	Per cent. living	Cost of planting per acre, including trees	Opinion of reforesting	Estimated acres of land in town that ought to be planted
Oswego	7,000	8	90	$10 00	Favorable	
St. Lawrence	15,000		95		Necessity	
Oswego	10,000	9	85	14 00	Necessity	
Hamilton	10,000	9	95	13 00	Favorable	10,000
Franklin	10,000	12	98	15 01	Investment	16,000
St. Lawrence	10,000	13	90	8 50	Necessary	5,000
Franklin	10,000	10	90	14 55	Favorable	1,000
Monroe	50		80			
Delaware	1,000	¾	99	10 50	Necessary	5,000
Chenango	1,000	1	70	8 00	Necessary	4,000
St. Lawrence	10,000	10	90	22 50	Favorable	5,000
Essex	6,000	3	80	12 00	Desirable	500
Franklin	2,000					
Warren	5,000	17	80	4 25	Necessary	10%
Yates	500	1	80	5 00	Desirable	Much.
Delaware	500	½	50	8 00	Favorable	5,000
Greene	750	½	90	8 50	Necessity	
Washington	3,000		90	10 00	Necessity	1,000
Lewis	1,000	¾	95	12 00	Investment	60%
Albany	3,000	3	95	7 50	Favorable	500
Rensselaer	1,000					
Westchester	1,000	1	92	15 00		
Fulton	2,000	2	95	10 50	Favorable	
Oneida†						
Saratoga	10,000					
Tioga	4,000					
Westchester	2,000	2	95	10 50	Necessity	400
Warren	3,000	3	90	5 75	Favorable	5,000
Chemung	3,000					
Oneida	2,000	2½	98	6 75	Excellent	Much.
Delaware	1,000		70		Excellent	2,000
Delaware	5,000	4	85	7 00	Excellent	
Madison	Refused					
Greene	1,000	3	60	4 00	Profitable	
Chenango	2,000	2	80	9 00	Necessity	25%
Delaware	60,000	35	85		Necessity	1,000
Chautauqua	200		75		Necessity	
Warren	2,000	1½	95	10 46	Necessity	5,000
Clinton	2,000	3	80	6 75	Favorable	400
Chenango	4,000	6	80	5 00	Necessity	1,000
Herkimer	5,000	3½		10 00	Favorable	5,000
Wayne	3,000	2½	60	7 00	Favorable	300
Saratoga	1,000					
Oneida	300		70	5 00	Favorable	500
Oneida	31,600					
Dutchess	1,000	1	40			
Clinton	4,000					
Suffolk	1,000					
Westchester	1,000					
Lewis	1,000	1	90	7 50	Favorable	Much.
Oneida	2,000	2	98	7 00	Favorable	Much.
Oneida	500	⅜	90	18 00	Favorable	1,500
Otsego	200	¼	95		Favorable	400
Livingston and Ontario	20,000	8	75	15 00	Very favorable	
Rensselaer	3,500	3				
Steuben	1,200					
Steuben	4,000					
Fulton	5,000	4½	95	6 00	Investment	4,000
Suffolk	3,000				Favorable	
Oneida	500	1	95	10 00	Favorable	100
Schoharie	2,000					
Steuben	1,000	1	95		Necessary	5,000
Franklin	500	½	95	14 00	Favorable	
Westchester	2,000	2	75	10 50	Necessity	5,000
Westchester	Canceled					
Yates	Canceled					
Otsego	1,000	1	90		Favorable	25%
Rensselaer	10,000					

Wherever blanks appear no report had been received when report was prepared.
anceled at applicant's request.

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Summary of 1909 Tree Distribution—(Concluded).

Application number	COUNTY WHERE PLANTED	Total trees planted	Acres planted	Per cent. living	Cost of planting per acre, including trees	Opinion of reforesting	Estimated acres of land in town that ought to be planted
136	Fulton	20,000	20	99	$5 00	Investment	....
137	Warren	3,000	3	98	9 00	Favorable	4,000
138	Fulton	3,500	3	95	8 80	Investment	7,000
139	Franklin	200	......	50	......	....	....
140	Schuyler§	....	......	....	......	....	....
141	Broome	3,000	2½	85	6 50	Desirable	3,000
142	Delaware	1,000	......	....	......	....	....
143	Erie	250	½	50	......	Favorable	....
144	Erie	1,000	2	75	......	....	....
145	Delaware	1,000	1	60	8 00	Desirable	33%
146	Herkimer	1,000	......	90	......	Desirable	4,000
147	Delaware	1,000	1	....	6 00	Desirable	2,000
148	Tioga	7,200	5	90	12 00	Necessary	1,000
149	Washington	24,000	20	98	8 28	Necessary	....
150	Franklin	800	2	90	4 00	Desirable	5%
151	Otsego	10,000	8	90	6 75	Desirable	1,000
152	Allegany	2,000	......	....	......	....	....
153	Delaware	500	½	90	6 00	Necessary	500
154	Rensselaer	6,500	......	....	......	....	....
155	Delaware	1,000	¾	75	5 00	Necessary	200
156	Delaware	575	½	60	8 00	Necessary	....
157	Essex	18,000	15	95	......	Investment	....
158	Franklin	1,000	1	90	5 00	Necessary	500
159	Columbia	2,000	......	....	......	....	....
160	Nassau	900	......	....	......	....	....
161	Suffolk	900	½	20	......	....	....
162	Suffolk	900	½	98	......	Favorable	....
163	Essex	5,000	4	98	8 00	Favorable	3,000
164	Chenango	1,000	1	50	7 00	Necessary	1,000
165	Essex	10,000	11	90	7 00	Necessary	....
166	Chautauqua	6,000	......	....	......	....	....
167	Hamilton	1,000	1½	98	6 10	....	10,000
168	Herkimer	1,000	2	95	......	Necessary	....
169	Schuyler	1,200	......	....	......	....	....
170	Westchester	1,000	......	....	......	....	....
171	Albany	2,150	2	80	......	Necessary	....
172	Putnam	600	*	....	......	....	....
173	Suffolk	2,000	*	....	......	....	....
174	Ulster	1,000	1	60	6 50	Favorable	2,000
175	Rensselaer	500	......	80	......	Important	....
176	Oswego	15,000	12	85	15 00	Important	....
177	Warren	10,000	11	80	10 00	Important	5,000
178	Warren	1,000	......	....	......	....	....
179	Lewis	6,000	10	90	5 72	Necessary	....
180	Franklin	500	½	90	6 00	Necessary	....
181	Fulton	2,000	2	90	7 75	Necessary	4,000
182	Franklin	700	6	90	3 00	....	....
183	Fulton	2,000	2	90	7 75	Necessary	....
184	Chautauqua	250	......	....	......	....	....
185	Franklin	3,000	......	....	......	....	....
186	Albany	Refused	......	....	......	....	....
187	Eric	Refused	......	....	......	....	....
188	Oswego	5,000	4	95	16 00	....	....
189	Oswego	9,000	7½	95	16 00	....	....

* Transplanted in garden for one year.

§ To be shipped in 1910.

This shows that through our efforts 1,000 acres of private land were reforested during the past year. The trees were set at various spacings from as wide as 10 feet by 10 feet to as close as 6 feet by 6 feet, and some of the trees were used for underplanting, while a quantity of seedlings was set in nursery rows for planting in 1910

n planted will increase the above acreage. The success
k is indicated by the very high percentage (average 90
living at the end of the first season, coupled with the
able opinions in regard to this work.

t variable figures are given for the cost of planting.
range from $3 per acre for underplanting, when 400
are set, to $15 to $16 per acre for setting transplants,
of 1,200 per acre; but in the latter case, excessive cart-
rience, high wages and board of men increased the cost.
l average, including cost of trees, when transplants are
by 6 feet (1,200 per acre) ranges from $8 to $10 per
everal cases, small plantings have been done at $6 to
.

a of the land in this State that should be reforested is
n the above table, based upon the reports received from
counties in the State. Also, an opinion can be formed,
the extent that it is very large, by traveling over the
s also indicated by the large amount of mail relating to
vhich is received every day in the year.

ination of the applications shows that several parties
g to protect their water supply, among these being both
vater works and commercial companies. Our largest
aper companies are planting in order to secure future
ulp wood. Many lumber companies are reforesting in
row lumber. The number of farmers and small land
are reforesting unused portions of their farms are the
rous, but they usually buy in small quantity.

e in this State thousands of acres of abandoned land
never intended for agricultural purposes and will pro-
l investment if properly planted.

nmission will be glad to assist private owners in this
as its time and ability will permit. It is the expectation
wners with the assistance of the information in this
will be able to proceed intelligently and successfully
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FORESTR
COLLEGE OF AGRICULT
UNIVERSITY OF CALIFORN

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EST PLANTING IN ARIZONA AND NEW MEXICO

BY G. A. PEARSON

Contributed

rpose of this article is to bring together the results at present
from the efforts toward solving the reforestation problem on the
Forests in the Southwest. The data here presented are based on
lanting operations in the Southwest and intensive experiments
rt Valley Experiment Station and the Fort Bayard Nursery.
o the year 1911 all attempts at artificial reforestation on the
Forests in Arizona and New Mexico had, with a few minor ex-
met with failure. In that year, as a result of the experience
ring the preceding years of failure, the tide turned, and since
ting has been conducted with fairly consistent success. All the
have been achieved by planting as distinguished from direct
So persistent have been the failures with direct seeding, despite
ars of extensive experimentation, that the method has practically
doned. While a discussion of the methods employed in direct
ight be of interest, it would lead to no practical end, and there-
article will deal only with planting.
light of recent knowledge, the main reason for the early failures
e use of poor planting stock. Other factors, such as improper
and poor sites, doubtless contributed in some instances, but poor
factor which seems to have been ever present and made failure
. The majority of the plants used in those days were of such
development that, according to present standards, they would

scarcely grade as second class. During recent years an effort has been made to remedy this defect.

NURSERY

The beginning of successful planting is in the nursery. The fact that the production of nursery stock is not an end in itself, but merely the means to an end, was too often overlooked in the first attempts at reforestation in this country. Cheapness of production rather than quality of stock was the object aimed at by the nurseryman. Size of top rather than root development was the criterion by which quality of stock was judged. In no region will these standards lead to such disastrous results as in the arid Southwest, where the young tree is taxed to the utmost to establish itself after planting.

The technique of ordinary nursery practice has been highly developed in the larger nurseries of the Forest Service, and therefore this phase of the problem will not be discussed in detail. I wish to deal more with underlying principles, considering the difficulties encountered and how to overcome them. The production of vigorous nursery stock is usually a comparatively simple matter. The problem in the Southwest has been to produce stock which would successfully withstand field planting. Lack of soil moisture, coupled with excessive water loss from the foliage at critical times, is the main cause of death in young planted trees. From May 1 to July 15 the total precipitation in the yellow-pine type is usually about one-half inch. This period is also characterized by strong winds and extremely low atmospheric humidity. The surface layer of soil to a depth of 6 or 8 inches dries out almost completely; but the deeper strata, which are usually of a clayey texture, retain considerable moisture even after several months of drought. It is evident, therefore, that if a young tree is to survive it must have a root long enough to reach the soil strata which contain sufficient moisture to sustain life. The roots must also have adequate absorbing capacity; they must extend over considerable area in the moist soil strata and must be supplied with an abundance of the fine rootlets or "feeders" which are most active in absorbing moisture. It is here that the stock used in the earlier plantings was deficient. The moisture problem is further solved by reducing water loss from the foliage. This is accomplished by inducing the development of a small but sturdy top. Western yellow-pine planting stock in the Southwest should have a well-developed root system not less than 10 inches long and a stem not over 5 inches long. In Douglas fir and Engelmann spruce, which normally develop shallower and more spreading roots and are usually planted on comparatively moist sites, ıst between root and top need not be so great as in western ıe.

tors more or less within control of the nurseryman, which are ortant in determining the development of the plant, are seed, ing space, water, protection, and cultivation.

e seed should be of high and known vitality is well recognized, fluence of the source of the seed has until recently been given ght in this country. The theory that the character of forest other plants, is determined to considerable extent by heredity ıerally accepted. It has been shown by a number of European ors that such characteristics as form, rate of growth, and even though resulting from soil and climatic conditions under mother tree grows, may be transmitted through the seed. The worthy investigation on this subject is that of Engler,[1] who d on exhaustive experiments with Scotch pine from various in Switzerland, Germany, Austria, Belgium, Russia, Norway, nd Scotland. The results of Dr. Engler's work are summa- ıe following quotation from a review by Prof. J. W. Toumey:[2]

> ıthor concludes from this comprehensive study of the Scotch from previous investigations that stands having poor growth- not suitable to collect seeds from for use in forest practice. th-form comes from adverse soil conditions and from the use m the wrong locality. In both cases the research shows it can itted through the seed. For each locality the indigenous spon- ine is the best to collect seed from for use in that locality. d, however, may be used when its origin is known. Thus seed and west Prussia is acceptable for use on low elevations in ıd, not to exceed 1,000 to 1,200 meters above sea-level. South ·ed may be used on the lowlands of north Switzerland. The pine may be expected to thrive on the dry soils of the Juras. exotic seed is used it should be with full knowledge of its de- of the locality where collected. This knowledge, however, can tained through government supervision. We now know that s in the cultivation of pine in the Swiss mountains in recent been due to the use of seed from the wrong localities.
>
> ears to the reviewer that the results of Dr. Engler's researches pine and Norway spruce and similar investigations in recent other investigators clearly show the necessity of giving more

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Arnold: Einfluss der Provenienz des Samens auf die Eigenschaften chen Holzgewachse. (In Mitteilungen der Schweizerischen Cen- für das forstliche Versuchswesen, Zurich, 1905, Vol. 8: 81-236; 1913, . 3: 1-386.)

ings Society of American Foresters, Vol. IX, No. 1.

attention in this country to the descent of the seed that we use in forest practice.

"With the use of such widely distributed species as western yellow pine, Douglas fir, and even white pine, the success attending their culture in any particular locality may be largely determined by the descent of the seed."

The result of 50 years of planting with Scotch pine in Sweden[3] shows that seed grown in France, southern Germany, and other regions of a decidedly milder climate than that of Sweden produces trees of very inferior form and so poorly adapted to Swedish conditions that entire plantations often die out at the age of 30 or 40 years. In reading Swedish articles on forest management one repeatedly finds the statement that trees of good form should be selected for seed production, since form is believed to be influenced by heredity as well as by soil and climate.

Experiments with western yellow pine at the Fort Valley Experiment Station show a marked difference in the germination of seed from different individual trees in the same locality. Young and vigorous trees which have reached the seed-bearing stage produce seed of considerably higher vitality than old, over-mature trees. Mechanical injuries, such as basal burns and lightning scars, appear to stimulate the tree to the production of better seed. Mistletoe and bark beetles appear to lower the vitality of the seed. No constant relation has been found to exist between the character of the mother tree and the resulting seedlings, but this phase of the experiment has not been carried far enough to yield definite results. Studies of this character are complicated by the fact that since tree flowers are generally fertilized by the pollen from a number of neighboring trees, only one of the parents is known.

Studies on the influence of the geographical origin of seed have not been carried sufficiently far in this country to establish final conclusions. Experiments with western yellow-pine seed from different regions at the Fremont and Fort Valley Experiment Stations, however, show a decided difference between the rate of germination and size and hardiness of the seedlings. Similar experiments with Douglas fir are being carried on at other experiment stations. These investigations should ultimately determine for each locality from what regions seed may be obtained. For the present the safest practice is to use only local seed, collected, as far as possible, from middle-aged, sound, well-formed trees.

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[3] Edvard Wibeck: "Tall ock Gran af Sydlig Härkomst i Sverige." Meddelanden fron Statens Skogsförsöksanstalt, Stockholm, Häftet 9, 1912, pp. 75-134. Reviewed in Proceedings of Society of American Foresters, Vol. IX, No. 1, pp. 113-119.

loam is generally considered the best soil for a nursery. A very
such as the adobe characteristic of large portions of the forest
Arizona and New Mexico, is difficult to cultivate, and appar-
t conducive to the development of roots suitable for planting.
sand is also objectionable, because it does not retain sufficient
The Fort Bayard Nursery is typical of the former type and
as Nursery of the latter. At the Fort Bayard Nursery an
eing made to improve the soil by adding sand and organic
the form of barnyard and green manures. At the Gallinas
ay is added in addition to organic matter.
nce at the Fort Valley Experiment Station, where the soil is
am, indicates that there is danger of applying too much barn-
izer, especially if not thoroughly rotted. A bed was treated
3 inches of old and fairly well rotted manure in the fall of
one-half of the bed it was spaded in, while in the other half
ed in a layer 5 to 8 inches below the surface. The stock pro-
ing the two years following was markedly inferior to that
adjoining non-fertilized beds. Apparently the decaying or-
er robbed the plants of the moisture in the soil, despite the
he bed was watered weekly. Undoubtedly the result would
different in a humid region or where facilities for heavy irri-
available. The best course is to apply only a moderate amount
and to grow a cover crop, preferably some leguminous plant,
ear. This should be plowed under early, so that it will rot
. If field peas, for example, are not plowed under until fall,
ill be more or less woody and the time for decay will be insuffi-
the result that this material will interfere with transplanting.

pace

as been a tendency in the past to pay too little attention to the
nt of seedlings, the apparent assumption being that the de-
necessary to produce a good transplant takes place in the
bed alone. As a rule, the seedlings are too dense, especially
are left in the beds until two years old. The characteristics
l seedlings are a slender form, with small crowns of few and
les, and a correspondingly small root system. Western yellow
rticular needs plenty of growing space. A seedling which has
fed in over-dense beds or has developed a tall, weak stem and
ge through excessive artificial shading, crowding, or too much
rs the transplant stage under a handicap. A dwarfed seed-

ling may recover under favorable conditions, but tall, spindling, th foliaged seedlings retain this undesirable form. Experiments indic that western yellow pine second-year seedlings should not be denser t 75 per square foot. Watering will also increase the capacity of beds; excessive watering should be avoided, because plants produced under s conditions would be poorly adapted to withstanding drought in the fi Douglas fir can be denser than western yellow pine, although no exp ments have been made to determine definitely the number per squ foot for this species. The number of seedlings which can be grown unit area varies with the species, soil, climate, water supply, and ot conditions. Therefore, rather than accept arbitrarily figures determi in other localities, this subject should be studied at each nursery.

Crowding in the transplant bed must also be avoided. Yellow p should not stand closer than 1½ inches apart in the row, while a 2-i spacing is better.

Water, Cultivation, and Protection

The care required varies considerably with location, soil, species, time of sowing. If the nursery is located away from settlements, little weeding will ordinarily be required during the first three or f years. If drill sowing is practiced, surface cultivation sufficient to k a hard crust from forming is desirable. This cannot be done when seed is sown broadcast. If the seed is sown in the spring, wateri mulching, and shading are necessary; if sown just before the beginn of the rainy season, water, mulch, and shade can be dispensed with t large extent, at least for western yellow pine. Western yellow pine ne comparatively little shade and water after the seedlings are a month Douglas fir and Engelmann spruce, on the other hand, are sensitive strong sunlight and drought. All species should be protected agai frosts which are likely to occur toward the close of the growing seas The common lath shades usually furnish sufficient shelter until the ginning of the winter. At the Fort Valley Experiment Station the l shades are put on all first-year seedlings about October 1 and left c tinuously through the usual clear, dry fall period. About November all first-year seedlings are mulched even with the tops with pine need Experience at Fort Valley and at the Gallinas Nursery indicates t Douglas-fir transplants, as well as seedlings, must be covered enti during the winter. This was strongly brought out during the wint of 1912-1913 and 1913-1914. Douglas-fir seedlings and transpla which were not covered were killed, and in covered beds wherever a protruded through the needle mulch it was brown. The same res xperienced with Engelmann spruce and exotics, such as Nor- Austrian pine, and Jeffrey pine. The only care given sec- estern yellow-pine seedlings is an occasional watering and uglas fir, Engelmann spruce, and most exotics require shade nt water in sunny weather, even in the second and third fe rule to follow in regard to shading is to give only as much ade as is necessary to prevent injury. This rule does not e same degree to watering, because too little soil moisture, western yellow pine, tends to develop an excessive tap root nse of the laterals; moreover, it may result in a distinct t only of the top, but of the root as well.

FIELD PLANTING

planting the conditions which determine success or failure ler the control of the forester than in nursery work. The ing reforestation already exist. Their soil and climate can- ged appreciably by artificial means. The factors more or control are the choice of species, class of stock, season, and planting. Upon the forester's judgment in regard to these ends the success of his work.

pecies

indication of the suitability of a site to a given species is the rrence of the species on the site. Development, abundance, sence of other species in mixture serve to indicate closer dis- 'or example, an area occupied by scattering, short-boled west- pine with more or less juniper or piñon, is to be regarded able for western yellow pine than a well-stocked area bearing western yellow pine in pure stand or mixed with Douglas fir. e of natural reproduction is also to be regarded as a favor- A dense growth of grass is undesirable; and short, turf-form- such as grama, usually indicate a drier, more compact soil tall bunch grasses. The presence of live-oak brush, mountain and sage-brush indicates drier sites than gambel oak or aspen. lred 1½–1 transplants of good development were planted on each year. With the exception of the limestone site, which ly denuded, fairly good protection is afforded by old trees. tion in the spring of 1914 showed that the planting on lime- both in 1912 and 1913 proved a complete failure. On rocky volcanic "malpais" soils about 78 per cent of the trees were od condition. On non-rocky flats with the same soil 39 per

cent survived from the planting in 1912 and 87 from 1913 plantin
On volcanic cinder soils, 37 and 58 per cent respectively. In the Dou
las-fir type (granitic soils), 61 and 44 per cent respectively.

The results of soil moisture determinations on the same sites in 19
follow:

TABLE 1.—*Soil moisture on planting sites*

Site.	Soil moisture, per cent of dry weight. Depth, 4-10 inches. Average of 3 samples.				
	May.	June.	July.	August.	Septem
Yellow-pine type:					
1. Limestone soil.........	16.4	3.9	2.2	9.8	4.
2. Volcanic "malpais" soil:					
a. Rocky ridge.......	22.7	13.8	6.8	19.3	10.
b. Non-rocky flat.....	21.7	13.8	9.2	17.3	5.
3. Volcanic cinder soil....	......	4.3	4.9	17.4	5.
Douglas-fir type:					
4. Granitic soil...........	......	15.3	10.8	12.5	7.

Although counts on Site 1 show a fairly high percentage of live pla
success is uncertain. The losses appear to be due not to the inability
the plants to establish themselves, but to top injuries, which are mai
the work of grasshoppers, a tip-moth,[4] the May-beetle,[5] and rode
Some damage also results from winter killing. These agents, except
the May-beetle, seldom kill the plants outright, but destroy the
growth from year to year, so that at the end of three or four years, w
counts may show as high as 80 per cent living, the trees are but li
taller than when they were planted. That this area is capable of
ducing western yellow pine is evinced by old stumps representing sta
equal to the best that are being cut in this region today. The pres
conditions are probably the result of destroying the forest, since the l
is practically denuded for miles around. The light, calcareous soil d
out rapidly, but this is compensated, in a measure at least, by the
that it has a low "wilting coefficient"—*i. e.,* only a small percentage
the moisture is non-available for growth. Probably the most seri

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[4] The species has not been determined, owing to the failure to find the in
in the adult stage. The eggs are deposited in the bud or young shoot.
June the larvæ are found to have hollowed out the shoot to such an ex
that it breaks off.

[5] The larvæ of the May-beetle feed on the roots of the pine. Usually
entire root system is destroyed, with the result that the plant suddenly d
up. Frequently, however, only a portion of the root is devoured, and
the plant may persist in an unhealthy condition for several months, or
even recover.

n resulting from deforestation is the establishment of a tall rass (*Festuca arizonica*), which saps the soil and harbors a mul- f insects and rodents. To reforest such areas as this, it may be y to screen young plants and to eliminate grass competition by or hand cultivation. The cost of these operations would be rohibitive.[6]

gives promise of good results. This site represents the optimum ns for western yellow pine in the district. The area is on an old on which about one-third of the original stand remains. The precipitation is about 24 inches. The soil contains a large pro- of adobe, which gives it a tendency to bake. It retains moisture t has a high "wilting coefficient"—*i. e.,* a high percentage of soil is non-available for plant growth. Perhaps the worst condi- e is the severe winters. In 1912-1913 much damage resulted nter killing. The plants were not, as a rule, killed entirely, but were injured. Very little damage of this character took place he winter of 1913-1914. The larvæ of the May-beetle kill from per cent of the plants during the first two years. The growing re frequently injured by the tip-moth. A few plants are cut off ed by rodents. While the above agents may be expected to re- stock by from 30 to 50 per cent during the first five years, it is that with a spacing of 6 by 6 feet the survivors will be sufficient a good stand.

nain difference between the flats and ridges is in the presence of The flats are comparatively free from rocks, while the ridges are very rocky, and consequently the soil is less compact. The flats, nt of their situation, are more subject to frost than the ridges. reproduction is generally most abundant on the ridges.

is on a Forest Service cutting area in the lower limits of the yellow-pine type. The subsoil is a heavy adobe similar to that 2, but the surface soil to a depth of from a few inches to 2 feet contains a large proportion of volcanic cinders. Sometimes the layer consists of almost pure cinders, but usually they are mixed ore or less clay. The adobe subsoil retains moisture well, and can be reached by the roots planting is usually successful. On le, this site is drier than No. 2, partly on account of coarse soil tly on account of lower precipitation. Very little winter killing

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tant District Forester Woolsey is authority for the statement that in he damage from rodents and drying out was much more severe where h and grass were only partially cleared. As a direct result of past e French are now usually removing all herbaceous and brush growth nting sites, notwithstanding the additional expense.

has been experienced. With respect to damage by insects and ro
Site 3 occupies a place between 1 and 2. The tip-moth is the
enemy. Natural reproduction in the vicinity shows almost every
up to 3 feet in height to have been injured by this insect; but ob
tions indicate that a large proportion will finally recover. The los
this site will be greater than on No. 2, but there is good reason to b
that planting will be successful.

Site 4 is an old burn, where the remaining stand consists of w
yellow pine, Douglas fir, and limber pine. Aspen has grown up in
thickets; but the yellow pine was planted in the openings where lit
no aspen occurs. The precipitation is about 30 inches, or 6 inches
than on the best sites in the pure yellow-pine type. The soil is o
nitic origin and contains more humus than is found in the yellow
type. Very little loss from winter killing and insects has been e
enced. Gophers do more or less damage by digging up or covering
plants. The comparatively poor results on this site are due mai
the fact that since the planting season is from two to three weeks
than in the yellow-pine type where the stock is grown, the stock m
held in storage to prevent growth. However, the second season's g
together with the development of native trees on the area, indicate
western yellow pine will do fully as well here as on the other sites.

Perhaps the most difficult sites attempted in District 3 are th
yellow pine-juniper cut-over areas on the Cameron Creek watersh
the Gila National Forest. Moisture conditions here are less fav
than in the pure yellow-pine type. The reforestation of this wate
was undertaken by the Fort Bayard Nursery in 1906. Western
pine is the main species used, although Jeffrey pine is promising.
gator juniper and piñon ought to succeed here, but on account o
growth and low commercial value they are not desirable. Arizo
press is exceedingly promising on north slopes. The plantings pr
1911 are largely failures due mainly to the use of poor stock. T
sults of experimental planting on various sites made in late winte
2–1 stock, in 1912 and 1913, are as follows (last examination was
in November, 1913): On open, level mesa 80 per cent survivals
1912 planting and 75 per cent from 1913 planting; in oak bru
south and southeast slopes, 71 per cent as a result of 1912 opera
on west slopes 58, and on steep north slopes 52 per cent (plan
1913).

The comparatively poor results on the north slopes are due pa
the fact that the stock had been dipped in kerosene emulsion
aphids. Another probable cause is the fact that, owing to the froze

ition of the soil on the north slope at the time the other sites were lanted, it was necessary to heel-in the stock for several weeks before lanting. This condition must usually be reckoned with in planting orth slopes. One of the best plantations on the Cameron Creek watered is an area of about five acres planted in January, 1911, on a southst slope in moderately dense oak brush. Fully 60 per cent are in rifty condition at the present time. An area of 70 acres, taking in rious sites excepting north slopes, planted in January and February, 14, is at the present writing a complete success.

The Douglas fir and Engelmann spruce planting areas are mainly on d burns above 8,500 feet elevation. Two general conditions occur, mely, aspen-covered and open areas. All observations thus far indite that the aspen-covered areas are most favorable. The shade of the pen checks excessive evaporation, but is not ordinarily dense enough injure young Douglas fir or Engelmann spruce. In heavy aspen ands it may pay to thin the nurse trees after the conifers are from 8 10 years old. There is generally little difference between the soil oisture content of aspen-covered and open plots. While evaporation om the ground is lower in the aspen stands, this is offset by the conmption by the aspens themselves. The results of two years' experiental planting with Douglas fir at the Fort Valley Experiment Stan, as shown by last examination in June, 1914, are: 31 per cent in od condition in the open and 47 under aspen cover (1912 planting); per cent in the open and 74 under aspen (1913 operations).

The stock in 1912 was poor and in 1913 fair. All of the planting was ne in early spring.

In all planting it is important to take advantage of local ground feares, such as slight depressions, the shelter of stumps, logs, or bushes, d spots where competition from other vegetation will not be excessive.

ason for Planting

Spring, summer, fall, and winter planting have been tested with pracally all species used. The experiments point conclusively toward the periority of early spring or, in some cases, late winter planting. Sumer planting makes it possible to take advantage of the summer rainy riod, when conditions for growth are optimum; but the disadvantage summer planting is that trees at that time are in a growing condition d therefore suffer more from the shock of transplanting than at other nes. The most common difficulty with fall planting is that the tops e subject to drying out during the winter, especially on sites which do t remain snow-covered. Another form of injury on heavy soils is frost heaving. In the yellow-pine type the soil is often too dry for planting in the fall. Winter planting is practical only where the ground does not stay frozen during long intervals. At the Fort Bayard Nursery western yellow pine is now generally planted late in January or February on the warmer sites. The advantage of spring or late winter planting is that the roots are in the ground at the first beginning of growing weather, while the tops are not exposed unduly long, as in the case of fall planting. In order to survive the long rainless period of May, June, and early July, it is important that the roots become established before the severe drought sets in. The soil is usually well saturated in early spring, but it grows steadily drier until the drought is broken by the summer rains in July. Plants which are set out as soon as the frost is out of the ground have from a month to six weeks of comparatively cool weather and abundant soil moisture in which to become established before the extremely dry period begins. If planting is delayed, the period for establishment is correspondingly shortened.

The above conditions are somewhat modified in northern New Mexico and in the higher altitudes of the entire two States, where the early summer dry period is less pronounced. Douglas fir has been planted in July and August, at altitudes of 9,000 to 10,000 feet, on the Coconino, Pecos, and Crook National Forests with a fair degree of success; but the results generally are in no wise comparable with those of early spring planting.

It may be stated as a general rule that for all species in Arizona and New Mexico the best time to plant is as early in the spring as the condition of the soil permits. The actual date may vary from January 15 on the lower southerly exposures to June 15 in the high mountains, where the snow persists late into the summer. If it becomes necessary to plant late in the spring or during the summer, the best possible sites, preferably near the upper altitudinal range of the species, should be chosen. For late spring planting it is advisable to hold back the growth of the stock as much as possible. This can be accomplished by heeling-in along a snow-bank in a protected situation at a high altitude. Experience has shown that stock cannot be kept in this manner much later than June 1. In summer planting the operations should be deferred until the soil has been moistened to the depth reached by the roots.

Stock

Several age-classes of stock have been used. In the following pages the designation indicates the number of years in seed bed and transplant bed. Thus 2–1 stock means plants which were grown two years in the seed bed and one year in the transplant bed.

Table 2 shows the development of western yellow-pine stock planted at the Fort Valley Experiment Station in 1913. Table 3 shows the results of planting in 1912 and 1913. The planting was on typical western yellow pine cut-over land at an altitude of 7,300 feet. One hundred plants of each class were used.

TABLE 2.—*Development of different classes of western yellow-pine stock*

Class.	Length (inches).		Character of root.
	Top.	Root.	
1½ seedlings	1½–2	6–8	Moderate lateral development.
1½–1 (first) transplants	2–3½	10–12	Good lateral development.
1½–1 (second) transplants.	2–3	8–10	Similar to first class, but smaller.
½-1-1 transplants	3–4	10–12	Bushier than 1½–1 first class.
½-2 transplants	4–7	10–14	Good lateral development, but coarser than the other stock.

TABLE 3.—*Results of different classes of western yellow-pine stock at the Fort Valley Experiment Station*

In good condition May, 1914 (per cent)

Class of stock.	Planting of—	
	1912.	1913.
1½–0	32	36
½–1–1	37	65
1½–1 (first)	44	87
1½–1 (second)		55
½–1	39	......
½–2	55	55

All the 1912 planting suffered severely from winter killing during the winter of 1912-1913. Some plants died from the effects; others remained alive but without leaders, while others fully recovered. Comparatively little injury was suffered during the winter of 1913-1914.

The larvæ of the May-beetle did considerable damage on some plots. The pine tip-moth also did more or less damage by killing the leaders. Of the 1912 plants now classed as living, from 10 to 25 per cent have dead leaders.

The ½–2 stock planted in 1913 dried up considerably in the tops during the dry foresummer. This is attributable primarily to the long stem (4–7 inches). On November 6, 1913, only 70 per cent of this stock was in perfect condition against 95 per cent of the 1½–1 stock. In 1912 the ½–2 stock was much shorter than the same class in 1913, which accounts for the good results in 1912 planting of this stock.

It seems to be quite conclusively established that the use of 1½-year seedlings is not advisable. A number of 2½-year seedlings thinned in the seed beds to approximately the density of transplants were field planted in the spring of 1914. This stock is expected to give better results than the 1½-year seedlings, although the root development is decidedly inferior to that of 1½–1 transplants.

Twice transplanted stock is too expensive, due to the extra cost of the second transplanting. The only case in which the use of this class of stock may be justified is when culls are placed in the transplant bed a second time instead of being thrown away.

First-class transplants, judging from the results of the 1913 planting, yield distinctly better results than second-class transplants. Whether it will pay to cull all plants of inferior development depends upon the site, the season, and the percentage of such plants in the stock. Ordinarily, if the stock runs 80 per cent or more of firsts, it will not pay to cull any except the very poorest plants. If, however, the stock runs as low as 40 per cent firsts, it will pay to cull the inferior plants and either discard or transplant them a second time. The data at hand are inadequate for definite statements as to when the latter action is advisable. The best solution of the problem is to grow stock with a high percentage of good plants.

The 1½–1 stock will probably prove the most economical in northern Arizona. While ½–2 transplants sometimes give good results, they are generally too large to withstand field planting well.

The results with different classes of western yellow pine at the Fort Bayard Nursery, planted in January and recounted in November, 1913, are as follows: 2–1 stock gave 37 per cent of survivals; 1–1 stock, 29; 1–1–1 stock, 27. The planting was on a brush-covered south slope of about 10 degrees—a very difficult site. Each class is represented by 200 plants.

On the whole, the best results with western yellow pine at the Fort Valley Experiment Station and the Fort Bayard Nursery have been obtained with 2–1 or 1½–1 stock. The difference between 2–1 and 1½–1 stock is that in the former class the seed is sown in the spring, while in the latter it is sown in July or August. Thus 2–1 stock is produced from seedlings which have had two full seasons in the seed bed, while 1½–1 stock is produced from seedlings which have had only 1½ years in the seed bed. Excepting in regions of very short growing season, 1½–1 stock is preferable, since the 2–1 stock is generally too large to handle economically. In regions of long-growing season it may be possible to produce 1–1 stock of good development, although experience at the Fort Bayard Nursery has been to the contrary.

Table 4 shows the character of different classes of Douglas-fir stock planted at the Fort Valley Experiment Station in 1913. The results in June, 1914, of planting in 1911 and 1913 are as follows: 1–2 Gallinas stock, 60 per cent (1911 planting); 1–1–1 local stock, 71 per cent (1911 planting); 1½-year seedlings, local stock, 38 per cent (1913 planting); 3-year seedlings, Frye Canyon Nursery stock, 45 per cent (1913 planting); 2–1 transplants, Gallinas Nursery stock, 73 per cent (1913 planting); 1–2 transplants, local stock, 68 per cent (1913 planting). The planting was on an aspen-covered burn in the Douglas-fir type at an altitude of 8,700 feet. One hundred plants of each class were used in each year's test.

TABLE 4.—*Development of Douglas-fir stock*

Class of stock.	Source.	Length (inches).		Character of root.
		Top.	Root.	
1½-year seedlings..	Fort Valley Nursery.	1–2	4–5	Short but well developed.
3-year seedlings...	Frye Canyon Nursery.	6–8	6–8	Fair.
2–1 transplants....	Gallinas Nursery.	1–2	4–5	Short but well developed.
1–2 transplants....	Near planting site.	1½–2½	5–6	Fair.

It is evident that very small seedlings, such as the 1½-year stock planted in 1913, are not suitable for field planting. On the other hand, extremely large stock is also undesirable. Observations in both 1912 and 1913 plantings indicate that the plants with very long tops suffer worst. While transplants will generally give the best results, it is believed that Douglas-fir seedlings of medium size (4 to 5 inches tall) can be planted successfully on favorable sites.

In all species age-class should be taken as a criterion only in so far as it indicates certain qualities. Generally 1½–1 or 2–1 western yellow pine transplants have the best root system and the best proportion between root and top, but sometimes 1–1 or 1–2 stock shows good development and yields practically the same results. In Douglas fir the best development is usually found in transplants, but seedlings are often sufficiently good to warrant their use.

Methods

The difficult conditions under which the establishment of trees takes place in the Southwest demand the use of careful methods. Because of the large root systems necessary to insure success in planting, fairly large holes must be dug. The roots must be spread out in a natural position and the soil firmed around them. The necessity for good planting is obvious when it is considered that immediately after the trees are set out they must withstand a period of two or three months with practically no rain. The quick methods sometimes used in regions of abundant rainfall, as, for example, where a plant with a short straight root is inserted in a slit made with an axe or spade, are out of the question in the Southwest.

In determining the size of planting holes necessary it was assumed at the outset that the depth must be equal to the length of the root and the width sufficient to permit the roots to be spread out in a natural position. The benefits sought in the use of extremely wide holes up to 12 inches or more are those usually resulting from cultivation, namely, improving the condition of the soil and eliminating competing vegetation. This principle was carried to the extent of spading up spots 2 feet in diameter a year before planting.

In the fall of 1910 a number of spots 18 to 24 inches wide were spaded to a depth of 12 inches. At the same time a number of holes 18 to 24 inches in diameter and 12 inches deep were dug and left open through the winter. The following spring western yellow-pine and Douglas-fir transplants, all excellent stock, were planted in the prepared spots and holes, and also in holes 6 to 8 inches in diameter dug in the virgin soil at the time of planting. In the spring of 1912 additional plots were planted, comparing holes 5 to 6 inches wide with holes 10 to 12 inches wide, all dug at the time of planting. The results for yellow pine (last examination in May, 1914) may be summarized as follows: In prepared spots on "malpais" soil, 38 per cent in good condition; on limestone, failure; in holes open over winter on "malpais" soil, 33 per cent; in holes dug at time of planting, 48 per cent on "malpais" soil and failure on limestone soil; in holes 5 to 6 inches in diameter, both on "malpais" soil, 40 per cent; in holes 10 to 12 inches in diameter, 40 per cent (1912 planting). The 1913 planting gave for the smaller holes 97 per cent of survivals and for the larger holes 91 per cent.

For Douglas fir the difference in the preparation of the soil did not result in marked difference in the per cent of survivals, being on an average close to 55.

The 1911 and 1912 plantings of western yellow pine suffered from winter killing in 1912-1913. This accounts in a large measure for the low percentage of plants in good condition. Many of the injured plants will doubtless recover.

The 1911 plantings show in the case of Douglas fir a distinct advantage of holes left open over winter, but no advantage is apparent in western yellow pine. There seems to be no advantage in prepared spots. The reason for the failure of additional cultivation to yield results is probably that the area cultivated was not large enough to eliminate root competition from surrounding vegetation. Soil samples show only a very slight excess of moisture in the cultivated spots as compared with uncultivated soil. Spots 3 or 4 feet in diameter would doubtless show a decided difference, but the cost would under ordinary circumstances be prohibitive. The cost of preparing spots is from $1 to $3 per hundred. This previous preparation facilitates planting in the spring, but the total cost of the planting operation is at least doubled. The cost, using holes 10 to 12 inches in diameter dug at the time of planting, is about 20 per cent higher than for holes 5 to 6 inches in diameter.

The results of these experiments indicate that the increased cost of preparing spots or digging holes wider than necessary for good planting is not warranted under usual circumstances.

The following planting methods have been tested:

1.—*"Side-hole" method.*—Roots spread out against the side of the hole. The advantages of this method are simplicity and speed. The main objection raised is that the roots are placed in a flat layer against the hard bank on one side of the hole.

2.—*"Cone" or "Mound" method.*—A cone or mound of fresh earth is formed in the middle of the hole. The plant is set at the apex of the cone, with the roots spreading on all sides. The advantage claimed for the method is that the roots are distributed better than by other methods. A disadvantage is that it is slow and difficult of execution by inexperienced men. The method is not adapted to stock with a poorly developed system of laterals.

3.—*"Middle-of-hole" method.*—The plant is placed in the middle of the hole, somewhat lower than its ultimate position, the roots being spread out on the bottom. As the soil is thrown in the plant is gradually raised to the proper elevation. The advantage claimed for the method is that in raising the plant after the first soil is thrown into the hole, thus drawing the lower portion of the root system through the loose soil, the roots are straightened out. It requires somewhat more time than the "side-hole" but considerably less than the "cone" method.

The results with western yellow pine planted by different methods at the Fort Valley Experiment Station are briefly as follows:

The 1912 planting gave for the "side-hole" method 24 per cent of survivals; "cone" method, 48, and "middle-of-hole" method, 39. The 1913 planting showed 83, 77, and 73 per cent survivals respectively for the three methods. The stock used was 1½–1 old and the observations were made in May, 1914.

For Douglas fir the 1913 planting gave for the "side-hole" method 74 per cent of survivals in June, 1914; for the "cone" method, 72; for the "middle-of-hole" method, 58.

None of the three methods shows consistent superiority over the others. In the 1912 planting of western yellow pine the "side-hole" method shows poor results, but in the 1913 planting it compares favorably with the other methods. In Douglas fir the "side-hole" method holds first rank. All of the 1912 yellow-pine planting suffered severely from winter killing, with the result that a high percentage have no definite leaders.

The results secured at Fort Bayard Nursery are more conclusive than those obtained at the Fort Valley Experiment Station.

In 1912 planting the "side-hole" resulted in 73 per cent living in November, 1913, and the "cone" method in 78.

In 1913 planting the "side-hole" gave 56; the "cone," 67, and the "middle-of-hole" method, 61 per cent living in November.

The order of merit for the three methods is: "Cone" method, "middle-of-hole" method, and "side-hole" method.

The time required to plant 100 western yellow pine by the various methods on heavy, more or less rocky soil, according to records at the Fort Valley Experiment Station in 1913, reduced to a 1–man basis. is as follows: "Side-hole" method, 3 2/3 hours; "cone" method, 6 2/3 hours; "middle-of-hole" method, 4 2/3 hours.

At the Fort Bayard Nursery the cost of the "cone" method is estimated 50 per cent higher than the "side-hole" method.

Reducing the results of the 1912 western yellow-pine planting at Fort Valley to the basis of cost per thousand living plants, placing labor at $2.50 per day and stock at $4 per M, the results at the close of the year 1913 are as follows: "Side-hole" method, $21.76; "cone" method, $27.58; "middle-of-hole" method, $21.26.

A similar comparison for the 1913 planting would be premature at this time.

In choosing between the three methods the "cone" method may ordinarily be eliminated as too expensive. It costs considerably more than the "middle-of-hole" method and gives but little better results. Between the "side-hole" and "middle-of-hole" methods there is a slight margin in favor of the latter in western yellow pine. The choice between these two methods should be governed more or less by circumstances. When it is necessary to employ inexperienced planters, the "side-hole" method will generally prove superior, because with this method there is less danger of bending the roots and of too deep or too shallow planting. On difficult sites the "middle-of-hole" method is surer of success. On the whole, choice of method is of less importance than efficient work and an understanding of the needs of the tree by the planter.

Costs

No reliable data on the cost of planting in District 3 are available. Since all of the planting has been on a comparatively small scale, overhead charges and cost of supervision have been unduly high. This applies particularly to nursery work. It is reasonable to assume that if circumstances should in the future warrant the establishment of large nurseries planting stock can be produced about as cheaply here as in other districts. At the Gallinas Nursery, where cheap Mexican labor is available, Douglas fir and Engelmann spruce have been planted at from $12 to $15 per acre. At the Fort Bayard Nursery, where western yellow pine is the principal species, where labor is comparatively high, and where careful work is necessary, the cost has been about $30 per acre. It is estimated that in large-scale operations the cost for western yellow pine will be from $15 to $25 per acre, and for Douglas fir and Engelmann spruce from $10 to $15 per acre, spacing 6 by 6 feet.

THE FUTURE OF ARTIFICIAL FORESTATION IN DISTRICT 3

The experiments cited in the preceding pages indicate that planting can, with the possible exception of certain sites—as, for example, large clear cuttings which have grown up to grass—be successfully accomplished in this region. The oldest experimental plantations are now in their fourth season. They show from 50 to 75 per cent of the plants living, but an average of from 10 to 20 per cent of these have top injuries resulting from insects, winter killing, and rodents. It is evident that a considerable loss must be expected before the plants are fully established. The same mortality is found in natural reproduction. Several sample plots were established on the Coconino in western yellow-pine reproduction from two to four years old in 1908 and have been examined yearly. One plot 50 by 100 feet containing 95 seedlings in 1908 had 18 alive in 1913, and of these only eight were in good condition. In another plot, out of 66 in 1908, 50 remained in 1913, and not one of these had a good top. These results are less discouraging when it is borne in mind that despite serious setbacks good stands are being established naturally, even on the most adverse sites. Many of the seedlings which now have dead terminals will doubtless recover and eventually develop good form. This opinion is supported by the fact that thrifty saplings up to 8 or 10 feet high almost invariably show pronounced bends in the lower part of the stem, indicating repeated top injuries in the past. It is common to find extensive areas of good reproduction in which almost every seedling below 3 feet high has top injuries resulting from the work of the tip-moth. Plantations will undoubtedly have to go through the same trials as are encountered by natural reproduction. Here a group will be injured by insects, while there a group will be entirely killed by the larvæ of the May-beetle. Large areas may lose half their trees during an unusually severe winter or dry spring. Some of the plantations will be irregular, perhaps requiring replanting; others, having the advantage of good sites and favorable seasons during the period of establishment, will be successful in one planting. In view of the heavy losses which must be expected, a spacing not wider than 6 by 6 feet is recommended.

Artificial reforestation will not generally be financially attractive in the Southwest, but it will nevertheless occupy an important place in the management of National Forests in this region. In discussing conditions under which artificial forestation is feasible it is necessary to distinguish between commercial and protection forests.

Commercial planting, because of the slow growth and the high cost of planting in the yellow-pine type, where the bulk of the merchantable timber occurs, will be limited to certain conditions. Limited areas denuded by heavy cutting will require planting to establish a stand. Returns from these plantations will not equal the cost of planting during the first generation. But when it is considered that after the stand is once re-established it will under proper treatment maintain itself by natural regeneration, the artificial reforestation of denuded timber lands seems to be a practical undertaking. On portions of our sale areas complete reproduction will not take place within a reasonable time after cutting. Under such conditions the planting of blanks to supplement natural reproduction may be warranted. The policy of cutting large mature trees and devoting the proceeds of their sale to planting when necessary rather than leaving them as seed trees at the risk of loss through windfall, lightning, or decay is advocated by many foresters. A characteristic arrangement in the yellow-pine forests is the occurrence of very heavy stands, yielding from 20,000 to 30,000 board feet per acre, in small flats, narrow valleys, or canyon bottoms, with open and usually short-boled stands on the adjoining ridges. The timber on the flats and bottoms is tall and often over-mature, so that frequently it is impossible to find an adequate number of suitable seed trees. On such sites it would be feasible to cut all the over-mature timber and plant where the cutting would leave an insufficient number of trees to secure natural reproduction.

On nearly all of the high mountain watersheds of the district burns of considerable extent are to be found. The greater portions of these burns are restocking; but there are thousands of acres in the Douglas-fir and Engelmann-spruce types which, owing to a lack of seed trees, cannot be expected to restock within two generations. Many of these areas are being occupied by grasses, and after a continuous turf is established it is doubtful whether the trees will ever regain a foothold without assistance from man. The value of high mountain forests for water protection renders it important that denuded areas be reforested. Moreover, these areas will produce stands of from 20,000 to 30,000 board feet per acre, and therefore planting may be warranted even from a strictly commercial point of view. Undoubtedly these high mountain burns offer the best field for planting in District 3.

SUMMARY

1. Reforestation by direct seeding is believed to be impracticable in District 3. Planting, on the other hand, promises to be successful.
2. The failure of the early attempts at field planting is due mainly to the use of poor stock.
3. In order to withstand field planting, the young tree must be able to maintain a safe balance between water absorption and loss. To do this, it must have a root sufficiently long to reach into the soil strata which retain considerable moisture through protracted dry periods; the root system must have laterals which will enable it to draw from a comparatively large soil mass; the roots must be provided with an abundance of active fibrous rootlets; and, finally, in order to avoid excessive transpiration, the top must not be too large.
4. The following conditions are required for the production of good planting stock:

a. Good seed. The seed should be of high germinating power, and it should be from trees of good form and development, indigenous, or from a locality whose soil and climate are similar to those of the region in which the seed is to be used.

b. Suitable soil. A rich sandy loam, neither too sandy nor too clayey, is preferable.

c. Sufficient growing space in the seed bed as well as in the transplant bed.

d. Sufficient water to produce a vigorous growth, but not so much as to make the plants excessively large and susceptible to drought, nor so little as to result in dwarfing.

e. Protection against sun, wind, and frost sufficient only to avoid injury.

5. The selection of species for a site should be governed primarily by the occurrence and development of the species growing on the site. Ground cover or underbrush may be used as a further index.

6. The best time to plant any species in Arizona and New Mexico is as early in the spring as the soil can be worked, and in any event before the stock has begun growth.

7. In western yellow pine the best stock has generally been found in 1½–1 or 2–1 transplants; seedlings have given poor results. In Douglas fir the best development is secured in 2–1, 1–2, or 2½–1 transplants, although three-year-old seedlings have given good results on favorable sites. Age-class should be taken as a criterion only in so far as it indicates desirable qualities.

8. No appreciable advantage has been experienced in the use of holes wider than necessary for good planting, nor in the use of prepared spots. These devices add greatly to the cost of planting.

9. The differences between the "side-hole," "middle-of-hole," and "cone" methods are not very striking. Considering cost as well as results, the choice lies between the "side-hole" and "middle-of-hole" methods. On the whole, the choice of method is of less importance than careful work and an understanding of the requirements of the plant.

10. Artificial forestation is destined to occupy an important place in the management of National Forests in District 3. The best field for planting is in the high mountains, where heavy stands can be produced and where the forest has a value for watershed protection in addition to its timber value. Commercial planting in the western yellow-pine type will ordinarily be limited to the reforestation of denuded areas and the restocking of blanks where natural reproduction is deficient.

In conclusion, it is well to bear in mind that our planting and nursery practice can never be reduced to a matter of rules. If no unexpected reverses are met in the next two years, we will have reached a point where it is safe to proceed on a larger scale. But this does not mean that the reforestation problem will be disposed of. Set-backs will undoubtedly occur as a result of infestations, abnormal seasons, and unusual site conditions. Moreover, there will always be room for improvement in methods. These conditions make it imperative that the men in charge of our nursery and planting operations be scientifically trained, practical, and alert like the modern farmer and business man.

BULLETIN IV.

OFFICE OF THE

NEW HAMPSHIRE FORESTRY COMMISSION.

Reforesting Waste and Cut-Over Land.

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Forestry Commission.

E. C. HIRST, State Forester.

CONCORD,
FEBRUARY, 1914.

NATURE'S SLOW METHOD OF REFORESTING WASTE LAND.

The

INTRODUCTION.

The interest in forest planting is increasing to such an extent that the Forestry Commission is not able to answer by letter each request for information on the subject. The purpose of this bulletin is to set forth the importance of reforestation both to land owners and to the state. Information is also given on how trees may be obtained for reforesting land within the state and how they should be planted.

Acknowledgement is hereby made to the U. S. Forest Service, publications of which have been consulted in the preparation of this bulletin. The yield of white pine per acre at fifty years, given in the table at the end of the bulletin, is taken from growth studies made in New Hampshire by C. A. Lyford and Louis Margolin of the Forest Service, and published in the New Hampshire Forestry Commission Report of 1905-06.

EDGAR C. HIRST,
State Forester.

WHAT INTEREST HAS THE STATE IN REFORESTATION?

Proper Use of Land.

Most of our material wants are supplied directly or indirectly from our greatest natural resource—the soil. The proper use of soil is a fundamental question. Upon it depends the support of the people and their prosperity for all time. Only a beginning has been made in properly determining the more detailed uses of the soil—such as the proper kind of rotation of crops for different classes of soil. But for most states experience and scientific study have already marked out two great divisions:—(1) soils best adapted for farming; and (2) soils best adapted for tree growth. Progress both in agriculture and forestry depends on a knowledge of what is *true agricultural soil* and what is *true forest soil.*

New Hampshire is naturally a forest state. Of our nearly 6,000,000 acres of land, it has been estimated from field studies of the U. S. Department of Agriculture that about 4,000,000 acres, or over 60 per cent. of the land surface of the state, is better adapted to forest growth than farm crops—*true forest soil.* While we are building up the producing capacity of our agricultural soils, it is also of vital importance for us to begin to produce in a systematic way the crop for which most of our land is best suited. Moreover, most of this 4,000,000 acres of natural forest land contains good elements of growth, and is unfit for farming only on account of its steep or rocky surface. The forest growth on such land is very rapid.

KEEPING UP THE TIMBER SUPPLY.

The industries which depend on forests for their raw material are of great economic importance to the state. The pulp mills, originally located here on account of our water power and accessible spruce and fir forests, have grown to such enormous proportions that a large part of the wood used is brought from Canada. There are over 450 sawmills operated in the state; and in addition some 420 manufacturing plants which make wood into a finished product. With all these industries in operation, wood is being cut many times as fast as nature is growing it. Our second growth stands of conifers are being cut away very rapidly, and a much heavier cut of hardwoods is beginning. The industries which depend on forest growth must either import a large part of their timber or discontinue, unless more wood is grown.

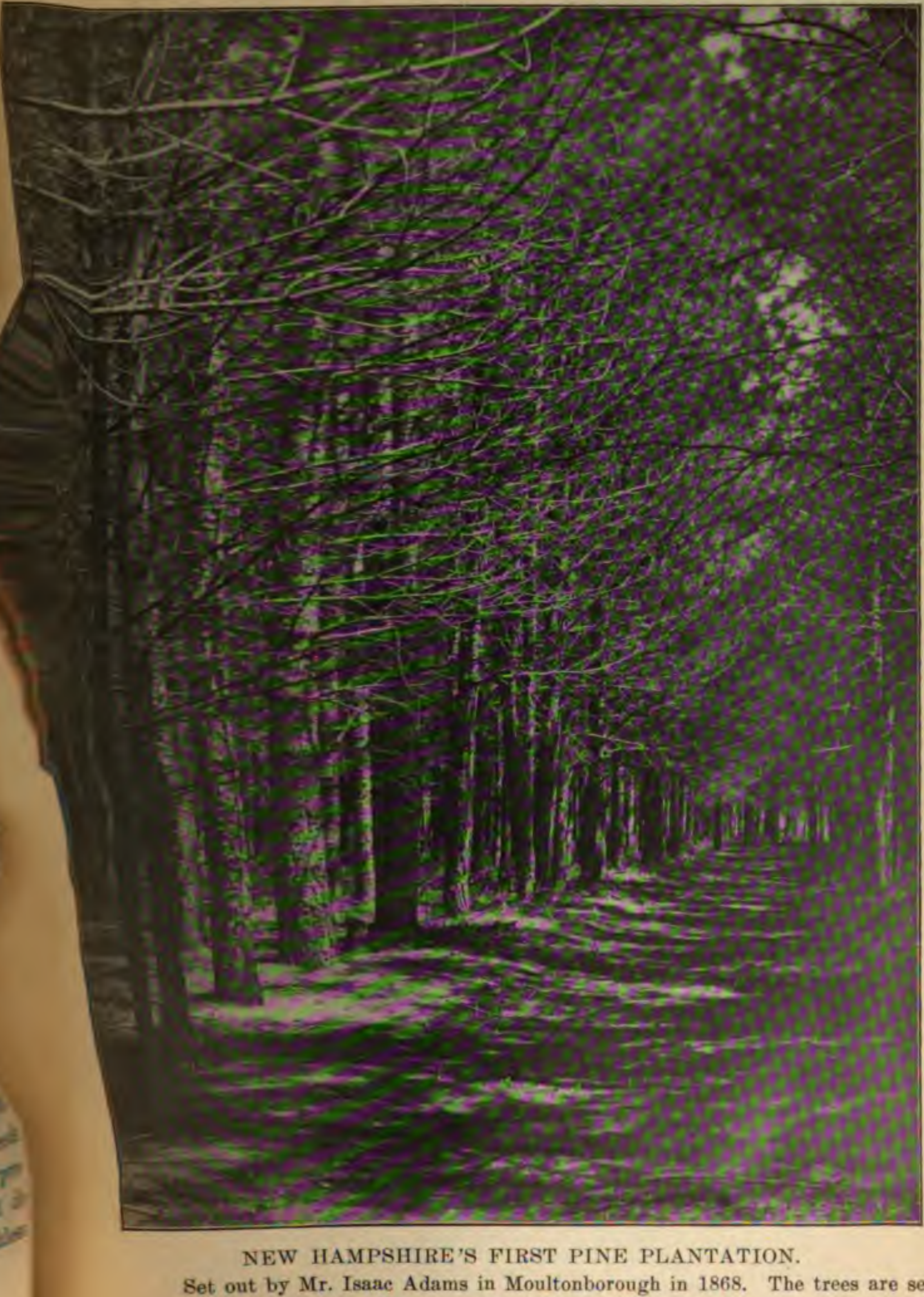
However, if proper forestry methods are inaugurated, New Hampshire will be able to produce enough timber to supply her industries permanently. When our 4,000,000 acres of true forest soil shall be kept in valuable timber growth by planting, adequate fire protection and proper forest management, enough timber will be produced to supply all our sawmills and wood-using plants. In other words, New Hampshire can continue indefinitely her threefold industry of growing timber, cutting it into lumber, and manufacturing the lumber into finished commodities.

EXTENT OF FOREST PLANTING IN NEW HAMPSHIRE.

The first forest plantation in New Hampshire was set out in Moultonborough in 1868, by Mr. Isaac Adams. Unfortunately the trees were planted too close together and very few of them have since been thinned out, so that this first plantation shows a much slower growth than later ones. After the first plantation was set out progress in planting was very slow. Only a small amount was done for the next 40 years. About 1905, interest began to increase and a number of plantations were started. By 1910, it was estimated that there were about 1,200 acres of planted forest in the state.

During the past three years the educational work of the Forestry Commission and the activity of local nursery firms have increased the interest in reforestation, and about 1,350 acres more have been planted. In 1913, there were about 900,000 forest trees planted (more than in any previous year), representing about 750 acres of land. At the present time, forty-six years since the first tree plantation was set out, there is only about 2,550 acres of planted forest in the state.

Of the 4,000,000 acres of forest land in New Hampshire, only a little over half, or about 2,250,000 acres, is in merchantable timber. Every year from 75,000 to 100,000 acres of this is cut over. Part of this cut-over land reseeds naturally and will again produce a valuable forest if protected against fire. There are also parts of it that do not restock naturally, or support only a scattered worthless



NEW HAMPSHIRE'S FIRST PINE PLANTATION.

Set out by Mr. Isaac Adams in Moultonborough in 1868. The trees are set 5 feet apart and have not been thinned out. They are too crowded and the growth has been greatly retarded. The proper spacing for white pine is 6 x 6 feet.

growth. Such land will not produce a valuable timber crop again for several generations unless it is reforested. There is also a considerable portion of land cut over in the past which has failed to reproduce any valuable growth and should be planted. Considering the amount of non-productive natural forest land in the state, it is very conservative to say that considerably over 25,000 acres of land should be reforested every year. This would require over 30,000,000 trees.

THE VALUE OF FOREST PLANTING TO LA OWNERS.

KIND OF LAND THAT SHOULD BE PLANTED.

There are thousands of acres of worn out pastures fields throughout New Hampshire that do not prod enough grass to be valuable as grazing land, or that can be farmed on account of the rocky surface. In some tions of the state there are vast stretches of sand barr that once supported splendid white and Norway p forests, but since cutting are only barren wastes of sc oak and pitch pine. A considerable part of the cut-o land on our better forest soils does not seed up quickly valuable trees; and when fire follows lumbering, the you trees of valuable species are still further reduced. E in most farm woodlots and larger timber tracts, there open patches where timber growth has not reproduc All such unproductive land, if planted to trees, will incre in value rapidly.

MOTH CONTROL.

The problem of stopping the spread and increase of gypsy and brown-tail moth has become so serious as to d courage many owners in exerting any effort in the care their woodlands. The work being carried on by the st and government is to check the spread of the gypsy m into new territory and develop parasites which will destr both the gypsy and browntail moths. Planting, especia in the southern and central parts of the state, should done with trees which are resistant to moth attack. C ifers are not attacked by the brown-tail moth, and not the gypsy unless mixed with hardwoods on which the gypsy caterpillars can live while young. Besides conifers the the only trees recommended in this bulletin are ash, basswood and poplars. All of these are fast growing; ash is not a moth food tree; basswood is not often injured; and poplars are recommended for planting only in the northern part of the state, well out of the moth infested region.

OWNERS WHO SHOULD BE ESPECIALLY INTERESTED IN FOREST PLANTING.

Farmers.

Nearly every farm contains some unproductive land on which the owner pays taxes, but gets no return. The ledgy, bushy parts of old pastures contribute very little to the support of live stock. In most cases, the better portion of a pasture, if fenced off, brought back into good grass and properly cared for, will carry more grazing stock than may be now supported on the original larger area. This will leave the poorer part of the pasture for profitable forest growth. Reforesting such land can generally be done by farmers with small initial expense, because often none or only a small part of the labor of planting the trees is a cash charge to them. It is more often a small investment of time. The prospective value of a young growing forest may be a strong incentive to the younger generation to remain at home and build up the farm. It is also true that if an owner later desires to sell his land, a young pine or spruce forest will greatly increase the sale value of the entire tract.

Summer Residents.

There are a great many land owners in New Hampshire who live here only a few months in the year. For some of them forest planting offers a means of the improving the scenic effect of their summer homes. Many of them also wish to put their land to some profitable use, and the problem of proper land management has become acute on account of the difficulty of securing labor and supervision while they are away. A forest plantation requires very little attention after it is once started. Summer residents, by investing relatively small amounts of money in reforesting land, can greatly increase the attractiveness and commercial value of their estates.

Towns, Cities, and Public Institutions.

Nearly 10,000 acres of land in New Hampshire is owned by towns and cities. Part of this is original, undivided land, and part is held for the protection of municipal water supplies. At the last session of the General Court, an act was passed authorizing towns and cities to purchase woodland, manage and improve it for revenue under the direction of the state forester.

The practice of forestry on land belonging to water companies and municipal water departments is becoming quite general. The cities of New Haven, Conn., New Bedford and Fall River, Mass., and the Pennichuck Water Company of Nashua, N. H., have for a number of years carried on careful forest management. Keene, Manchester and Concord have had definite plans made for cutting and reforesting. The two latter cities have already planted nearly 100,000 trees. It is necessary for most cities and large towns to own land draining into reservoirs in order to preserve the purity of the water supply. A forest cover on such land conserves the moisture by checking wind evaporation from the soil, retarding the melting of the snow and surface run off, and allowing more of the water to reach the streams by underground seepage. A forest plantation therefore serves a double purpose of protecting the water and producing a considerable incidental revenue.

There is also a large amount of natural forest land owned by the public in connection with county farms, state institutions and various town enterprises which is producing no income. The Forestry Commission is prepared to furnish trees and arrange for the planting of such land at a very small cost.

Corporations.

A few boxboard and pulp companies have begun forest planting. But generally there is very little reforesting carried on by lumbermen, because for most of these industries the price at which they can buy merchantable stumpage and young growth is not high enough to induce them to invest in planting. There are other corporations, however, to which forest planting would add an incidental profit. Quarry firms, water power companies, and various public service corporations and private business concerns are obliged to own tracts of land for long terms of years which produce little or no revenue. The production of timber crops by planting would be a profitable use for such land.

HOW PROFITABLE IS A FOREST PLANTATION?

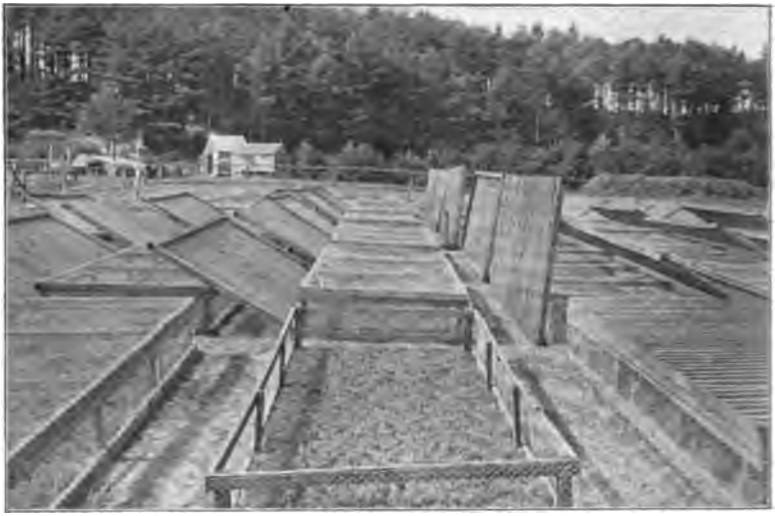
Safe Investment, Moderate Returns.

Land owners who contemplate forest planting are reminded that it is not a ''get-rich-quick'' scheme. It is a safe, profitable way of making small or large investments which will increase steadily in value over a long period of time. Depending on the kind of trees used, the quality of the soil and the skill and judgment used in carrying out the enterprise, a forest plantation may pay from 4 per cent. to 8 per cent. compound interest.

TAX ABATEMENT ON PLANTED LAND.

Tax abatements for thirty years are allowed on land where 1,200 trees or more are planted per acre. The spacing 6 x 6 feet advised for most plantations requires 1,210 trees per acre. The section of statute covering the case is quoted from Chapter 124, Laws of 1903.

SECTION 1. In consideration of the public benefit to be derived from the planting and cultivation of timber or forest trees, the owners of any and all land which shall be planted with timber or forest trees, not less than twelve hundred to the acre, shall be entitled, from and after the first day of April, 1903, to a rebate of the taxes assessed upon said land, as follows: For the first ten years after the land has been so planted, a rebate of ninety per cent. of all the taxes assessed upon said land; for the second period of ten years after such planting, a rebate of eighty per cent. of all taxes, and for the third and final period of rebate after such planting, a rebate of fifty per cent. of all said taxes; said rebate to be allowed only on condition that said planted trees are kept in a sound condition. A return of such planting shall be made to the selectmen when taking the annual inventory, which return shall be verified by the selectmen and made the basis of such tax exemption. After said trees have been planted ten years it shall be lawful for the owners to thin out the same so that not less than six hundred trees shall be left to the acre; but no portion of said planted land shall be absolutely cleared of trees during the period for which said rebate may be allowed.



WHITE PINE SEED BED, STATE NURSERY, GERRISH, N. H. When the seeds germinate a thick mat of young pines covers the bed. They grow here two years before transplanting. The lath shade covers protect them from intense light the first year; the wire screen is to protect them against birds and rodents.

WHITE PINE TRANSPLANT ROWS. When the seedlings are 2 years old they are removed from the seed bed and grown for a year in nursery rows. This transplanting develops a stockier tree with a stronger root system.

THE STATE FOREST NURSERY.

The Forestry Commission maintains a nursery at Gerrish where trees are grown for distribution within the state. The tree seeds are sown in carefully prepared beds in early spring and germinate in from two to three weeks. The young trees require careful attention during the first summer. They are kept under artificial shade and must be sprinkled and weeded. Coniferous trees are allowed to grow in the seed bed until they are two years old, when they are three to six inches high and strong enough for planting in very favorable situations. Some of them are taken from the seed bed and set out in nursery rows, where they are allowed to grow for a year or more. This transplanting process develops a stronger root system and the trees are more likely to survive under adverse conditions. Trees that are grown only in the bed in which the seed was sown are called *seedlings*. Trees that are taken from the seed bed and grown in nursery rows are called *transplants*. Hardwood trees are large enough for planting when they are one or two years old.

KINDS OF TREES TO PLANT.

The trees grown at the state nursery are the commercial conifers and the hardwoods which are resistant to insects and disease. The following species are best adapted for planting on the soils of New Hampshire:

White pine is used more than any other tree in reforesting lands in this region. It will thrive on almost any of our soils where the drainage is good and where there is no hard clay subsoil. The growth is rapid, being better on the more fertile soils. White pine will stand light shade in early life and can be planted successfully under very open stands of pitch pine or gray birch. Later on it requires full sunlight and should never be planted among trees that it cannot grow through and overtop. It will stand full sunlight from the first and may be planted on open grass land. It is much safer to use transplants than seedlings. Depending on the quality of the soil, a white pine plantation should produce from 27 to 47 M. board feet per acre in 50 years.

Norway or red pine in early life grows faster than white pine. This is especially true on coarse gravelly or light sandy soils. It will give a larger return for a short rotation on light land than white pine. For a longer growing period, however, on better soil white pine will produce more timber. The lumber is not so valuable as good grades of white pine, but in the lower grades the two species bring about the same price. Norway pine is peculiarly resistant to all disease and insect attacks. It will not stand shade and should be planted only on open land.

Scotch pine is a native of Europe, but has been planted here to a considerable extent. It shows remarkably rapid growth in early life and produces about the same grade of lumber as red pine. It is a good tree to plant on sandy or gravelly soils. It requires full sunlight from the start, and should not be used in underplanting. Both Norway and Scotch pine are larger and stronger when young and may be planted as two-year-old seedlings with greater safety than white pine.

Norway spruce is a native of Germany. It is planted here on soils that are suited to our native red spruce. It grows much faster than red spruce and is valuable for pulpwood and lumber. The roots are shallow and the tree should therefore be planted only on soils that retain moisture well. Norway spruce will endure moderate shade and is a good tree to use in underplanting such hardwoods as popple and birch. On favorable soil, it will grow almost as fast as white pine.

European larch is another tree introduced here for reforesting land. Unlike our American larch, it is not a swamp tree, but thrives on strong, well drained, upland soil. It is not suited to very sandy soil. It begins to grow very early in the spring; and unless planting can be done as soon as the frost is out, it is better to plant larch in the fall. It does not grow as fast as white pine, but produces crops of posts and poles on short rotations. It is recommended for planting to grow poles in the chestnut region of New Hampshire where the bark disease is killing the chestnut trees. European larch should not be planted in places where there is great danger from frost. It requires full sunlight, so should not be used in underplanting.

Balsam fir is a good tree to plant on moist land. It will grow in soil too swampy for most other trees and will survive considerable shade. It is a fairly rapid grower, and is used for pulp and rough lumber.

White ash is a fast growing tree and the lumber brings a good price. It can be marketed when quite young, as the sapwood has very high technical value. The tree requires good soil and full sunlight for proper development.

Baswood makes very valuable lumber and is a fairly rapid grower. It requires fertile, moist soil, and can endure shade early in life. Later it requires full sunlight.

Poplars, or aspens, are fast growing trees and the wood is valuable for pulp, excelsior, boxes, baskets, etc. In addition to the native species, the Carolina poplar or cottonwood and the Norway poplar are used in forest planting. Poplars require good, moist, but well drained soil to maintain rapid growth. They will not stand shade nor close planting. They may be planted either as rooted seedlings or as cuttings.

SPRING AND FALL PLANTING.

Forest trees may be planted successfully in the spring before the new growth starts, and in the fall after the season's growth has stopped.

If planted in the spring the trees should be set out as soon as possible after the frost is out of the ground, but before the buds start to grow. Spring planting is generally safer because there are usually rains during or following the planting season which get the trees set to the ground and give them a start.

If planted in the fall the trees start earlier in the spring and make a better growth the first season. Planting should not be done until the summer growing season is over and the new wood has had a little chance to harden. Labor is a little easier to secure in the fall than in the spring; and the fall planting season is generally longer than the period in the spring during which planting is safe. The only danger from fall planting is that the trees may be thrown by freezing and thawing during the winter and early spring. Hence, fall planting should not be done on low, moist land.

SCOTCH PINE PLANTATION.
(Courtesy of the Forest School, Syracuse University.)
Scotch pine grows faster than white pine in early life. It is adapted for planting on loose gravelly soils.

How to Secure Trees.

The trees raised at the state nursery are shipped to land owners within the state who order them on blanks furnished by the Forestry Commission. The blank, when filled out, states the number and kind of trees which the owner desires, and the purchase price is either enclosed or the owner agrees to make payment prior to the delivery of the trees. The orders are filed in the order of their receipt and when payment is made the owner is credited with the number of trees which he is to receive, and is so notified. A notice is also sent several days before the trees are shipped.

Prices are quoted f. o. b. shipping point, the purchaser paying the transportation charge. Trees are shipped from Gerrish, N. H., and Keene, N. H. For spring planting, orders must be in the hands of the State Forester by April 20. For fall planting, orders must be received by September 15. When the supplies at these points are exhausted, trees will be secured and shipped from other New England nurseries. If the trees ordered cannot be obtained the purchase price is refunded to the owner.

On account of the expense in packing, the Commission does not take orders for less than 1,000 trees, and no trees are shipped for decorative planting on private land. When such orders are received the owners are referred to commercial nurseries making a specialty of such work.

REFORESTING OPERATIONS.

Starting a Forest by Sowing Seeds.

Broadcast Seeding.

This consists in scattering seed as evenly as possible over the surface to be restocked. The results have generally been unsatisfactory. If there is a heavy cover of brush or grass on the ground, very few seeds come in contact with the mineral soil and so fail to get rooted if they germinate. If dry weather follows sowing most of the seeds fail to germinate. If the weather is too damp the seeds may rot, or the young seedlings are likely to die from the attack of a fungus called "damping off." Where a lumbering operation has left very light brush and has stirred the ground surface well, exposing the mineral soil, or on north slopes under light shade of such trees as poplar and birch where moisture conditions are very favorable, it is sometimes possible to secure a stand of young trees in this way. In general, broadcast seeding is inadvisable. Planting young trees is much safer and little more expensive.

Seed Spot Sowing.

Next to broadcasting, seed spot sowing is the simplest method of reforesting. It consists in sowing the seeds in prepared spots distributed regularly over the surface to be restocked. In the case of white pine, the spots are generally about a foot square and 4 or 5 feet apart. They are made by taking off the turf with a mattock or heavy hoe. In each spot, 10 or 15 seeds are sown from one-fourth to one-half inch beneath the surface. In the North Eastern States greater success has been attained by the seed spot method than by broadcasting; but it depends very largely on moisture conditions, and therefore may succeed in some seasons and completely fail in others. In the plantations which have been established by this method, the restocking has varied from 30 per cent. to 75 per cent. of a complete stand. It is but little less expensive than planting young trees.

PLANTING WILD SEEDLINGS.

A few plantations have been established by taking up seedlings from ground where they have come up naturally and setting them out on the land which it is desired to restock. It sometimes happens that a very thick stand of young pine will come up in pasture or field where they are not desired, and that the poorer, ledgy part of the pasture fails to become seeded. The natural thought of the owner is that the trees should be transferred to the poorer land. This can sometimes be done successfully if the seedlings are very dense and small enough to be removed cheaply. They should be under 12 inches in height and should not be taken from shady places to be planted in the open, as they may not be able to stand the changed light conditions. Great care must be taken to keep the roots wet while the trees are being transferred. Wild seedlings are seldom so well rooted as nursery grown trees, and generally the cost of taking them up exceeds the cost of nursery stock. Before planting wild seedlings on a large scale, the relative cost of the completed plantation for both kinds of stock should be carefully calculated.

PREPARING LAND FOR PLANTING.

No preparation of the land is necessary in planting the ordinary open pasture or field. If bushes are numerous they should be cut, so the young trees will not be shaded. This is especially important with the light-demanding trees. On cut-over land, if the slash is light, it should be lopped and scattered before planting. If the slash is heavy, it should be piled and burned. If brush is burned between April 1 and November 1, the owner must get permission of the town forest fire warden.

CARE OF TREES.

When the trees are received they should be unpacked as soon as possible, then "puddled" and "heeled in" until planting is begun. This may be easily done as follows:

In a pail or tub prepare thin mud with earth and water, making it about the consistency of very thin paste. As each bundle of trees is taken from the box, cut the string and loosen the bundle somewhat for the better circulation of the air, and puddle the roots in the mud paste. This will give the rootlets a coating of mud and prevent their drying out. The trees should be heeled in in a trench deep enough to permit the roots and part of the stems to be covered, but not to cover any of the foliage. The bundles should be placed close to each other, one row of bundles in each trench. Unless the place where they are heeled in is shady, they should be protected from the hot sun or drying winds by piling brush over them or by other light artificial shade. In this condition the trees can be kept with safety a week or two while planting is going on.

THREE-YEAR-OLD WHITE PINE TRANSPLANT.

This is the size generally used in reforesting land in New Hampshire. They are strong, well-rooted trees, and set from 6 to 10 inches above the ground when planted.

WHITE PINE PLANTATION MADE IN 1875 IN WESTMORELAND.

The trees were set out 8 x 8 feet on a barren, gravelly hillside. Thirty five years after planting it measured 30 M. b. ft. per acre.

METHOD OF FIELD PLANTING.

In case the planting operation is small and the trees can be planted soon after they arrive, it is not necessary to heel them in. They should be taken to the planting site, the box unpacked, the bundles loosened and puddled in the pail in which they are carried for planting in the field.

The men should be organized in crews of two. One man digs the holes with a mattock, the other follows with a pail in which the trees are puddled and plants a tree in each hole. If the planting is done in heavy grass, a few strokes of the mattock will clear away a small piece of sod and give the young tree a better chance to grow. The hole should be deep enough to permit the roots to occupy as nearly a normal position as possible and to be planted slightly deeper than in the nursery. Two men, under average conditions, will plant 800 to 1,000 trees per day. The trees may be set at different distances apart, varying from 5 x 5 feet to 10 x 10 feet, depending on the species and the product desired. Conifers are usually planted 6 x 6 feet. White ash may be spaced a little wider; 8 x 8 feet would give it enough growing space in early life. Poplars should not be spaced closer than 8 x 8 feet, and 10 x 10 feet would be better.

On moist situations Norway spruce or balsam fir may be planted alternately with white pine. If the pine is set 6 x 6 feet and the fir or spruce set in the centers of the squares thus formed, the trees will be evenly spaced 3 feet apart. In from 8 to 10 years, the fir and spruce will yield an incidental revenue if cut and sold for Christmas trees. Fir and spruce for the same purpose are also well adapted for planting among white ash and poplar. The latter trees will be spaced wider than white pine and will give the conifers a little more space to develop into symmetrical Christmas trees. The moist soil required for ash and poplar will grow fir and spruce faster than will the average pine soil.

3 x 3 spacing requires 4,840 trees per acre.
4 x 4 spacing requires 2,722 trees per acre.
5 x 5 spacing requires 1,742 trees per acre.
6 x 6 spacing requires 1,210 trees per acre.
7 x 7 spacing requires 888 trees per acre.
8 x 8 spacing requires 680 trees per acre.
10 x 10 spacing requires 435 trees per acre.

The trees should be planted in rows, at even distances apart, so each will have an equal growing space. This may be done easily by setting up flags for the crews to work towards. For instance, if a field is going to be planted with trees spaced 6 x 6 feet, the first crew begins to dig the holes 6 feet inside the boundary, the next crew 6 feet farther on, etc. If flags are set up 6 feet apart on the other side of the field, the men who dig the holes can keep lined up by them and by each other, and can space off 6 feet as accurately as is consistent with rapid work.

A very good method that has been used successfully where plowing can be done is to plow parallel furrows across the field and then set the trees at even distances in the bottom of each furrow. This method is especially good on sandy lands, as the trees can be set deeper. It eliminates grass competition and gets the tree roots down to the lower moist layers of loose soils.

A tool has been invented by which one man can dig the hole and set the tree at one operation. It can be used, however, only on good, mellow soil, free from rocks. The Forestry Commission will furnish detailed information on the subject to planters whose land will permit the use of this tool.

In planting poplar cuttings it is not necessary to dig a hole. The cuttings are 12 to 15 inches long. They should be stuck in the ground in an upright position with two buds above the surface of the ground and the soil firmed around the cutting.

CARE OF THE YOUNG PLANTATION.

After the plantation is made, very little care is required until it is old enough to be thinned, which would ordinarily be at about the twentieth year.

If there is danger from fire, a good means of protection is to make a fire line around the plantation or on the side where the greatest danger lies. This is done by cutting the brush and clearing the ground of inflammable material on a strip about ten feet wide. Fire warning notices for posting such land may be obtained upon application to the town forest fire warden.

For the first few years the plantation should be watched so that bushes may be cut that are shading the trees too much, and blank spaces where trees have failed may be replanted. If the plantation at any time appears unhealthy, the owner should notify the Forestry Commission. Advice will be given on the best measures to use, or the owner will be notified where expert advice may be obtained in case disease or insect enemies are attacking the trees.

ESTIMATED COST AND RETURN FROM A WHITE PINE PLANTATION.

ESTIMATED INITIAL COST PER ACRE.

Trees—spaced 6 x 6 feet; 1,210 per acre at $5 per M.,	$6.05
Transportation—freight or express and hauling,	1.00
Planting—2 men at $2 per day,	4.00
	$11.05

COST OF THE PLANTATION PER ACRE AT 50 YEARS.

(All expenses compounded at 5 per cent. to the end of the 50-year rotation.)

Quality of soil.	Planting cost with accrued interest to end of rotation.	Interest on land value accrued to end of rotation.	Taxes on land and timber accrued to end of rotation.	Protection 10 cents per acre per year, accrued to end of rotation.	Total expenses.
Best quality pine soil; value $6 per acre.	$126.71	$62.80	$72.16	$20.93	$282.60
Poor quality pine soil; value $3 per acre.	$126.71	$31.40	$43.67	$20.93	$232.71

YIELD AND PROFIT PER ACRE AT 50 YEARS.

Quality of soil.	Yield of timber, board feet.	Value of timber.	Total cost of producing timber crop.	Net profit.
Best quality.	47,450	$474.50	$282.60	$191.90
Poor quality.	27,650	$276.50	$232.71	$43.80

In making the above calculations it is assumed that in 50 years white pine stumpage will be worth $10 per M. board feet. This is a conservative estimate. Taxes are calculated at 1 per cent. on the full value, allowing for a re-valuation every five years.

According to these calculations a white pine plantation, depending on the quality of the soil, will make a profitable 50-year investment; paying from a little less than $1 to nearly $4 per acre per year, in addition to 5 per cent. compound interest on all money invested.

NEW HAMPSHIRE COLLEGE AND EXPERIMENT STATION.

(Extension—Press Bulletin No. 39.)

PLANTING FOREST TREES.

By J. H. Foster.

There is always a period in the spring before farm work begins when a little time can profitably be spent in planting some neglected corner of the pasture or a part of the pine lot which was recently cleared without leaving seed trees so that nature could reforest. The fact that the owner cannot harvest the timber next year or even in his lifetime should not deter him from thus increasing the value of his property wherever this may be done. A partly mature stand of quick growing trees of marketable species has a very distinct value today, and this value may easily increase $5 to $8 an acre yearly. It is not a difficult task to plant an acre with young trees which will be worth $300 to $400 or more to the children some day.

There are two general methods of forest planting; namely, planting or sowing seed, and planting seedlings. The former is not to be recommended although good results have sometimes been secured. Sowing broadcast as much as 4 or 5 pounds of seed to the acre may fail entirely if there is a dry leaf litter on the ground, or if dry weather prevails before or after the seed germinates during the first year. The cost of white pine seed from a dealer averages about $2 per pound. During a good seed year the cones may be collected quite easily and a bushel of cones produces about one pound of seed. They must be gathered before the scales open in September. The best method of direct seeding is to clear spots about a foot square six feet apart with a grub hoe and drop a dozen or more seeds in each spot, pressing them into the soil with the foot. In this way one and a half pounds of seed will plant an acre. Even this method is much less satisfactory than planting young trees.

There are two kinds of plants used—seedlings and transplants. Seedlings have been grown under cultivation in seed beds generally two years. Transplants are seedlings which have been removed from the beds and given an additional year or more in nursery rows. They are stronger rooted and better to use where conditions are unfavorable. Two-year-old seedlings cost about $2 to $3 per thousand and three year old transplants (grown one year after transplanting) cost about $6 per thousand. The seedlings or transplants are set out in rows, preferably, six feet apart each way. This requires 1,210 plants per acre which is the spacing commonly used. The planting is done most rapidly with a grub hoe. Care must be used to prevent the roots from drying out. The seedlings should be kept in a pail with wet moss while the planting is going on.

Two men with grub hoes and a boy to hand them the seedlings one at a time, can plant an acre per day. The planting, including labor and purchased stock, should be done for from $8 to $12 per acre. On the farm the labor cost may be disregarded.

Only a few kinds of trees need be considered in forest planting. White pine is perhaps the best tree for our New Hampshire conditions. It grows rapidly and we are familiar with its market values. Norway or red pine, also native in the state, will grow on very poor soils, is hardy and vigorous and an admirable tree for planting. Douglas fir, Norway spruce, and European larch are all good trees for planting in New Hampshire and may be obtained for uniform and reasonable prices. Douglas fir is native in western United States and has wood of high value. Norway spruce is commonly planted for ornamental purposes and is a rapid grower. Its wood has a high value for paper making. European larch, similar to our native tamarack in appearance but growing much more rapidly, is adapted to dry soils and becomes a large tree. The only broad-leaf trees recommended for planting are white ash and basswood.

Wild seedlings may be used but their root systems are inferior to those of nursery grown seedlings and the expense of digging them is considerable. They should not be over eight to twelve inches high for rapid planting and successful results and seedlings grown in the open are preferable to those found in the shade.

Seedlings or transplants of white and Norway pine, Norway spruce and Scotch pine, another quick growing pine from Europe, may be purchased from the state upon application to the State Forester, Concord, N. H. Requests for stock should be made as far in advance as possible. Prices range from $2 to $6 per thousand, depending on species, age and size. Several commercial dealers also furnish stock of many different kinds at reasonable prices. Some will also plant the trees and guarantee them to live over the first year. Further information in regard to planting will gladly be furnished by writing to the Agricultural Experiment Station, Durham, N. H.

Approved:—

J. C. KENDALL, *Director.*

DURHAM, N. H., March, 1914.

FORESTRY
COLLEGE OF AGRICULTURE
UNIVERSITY OF CALIFORNIA

Walter Mulford

Oklahoma Agricultural Experiment Station,

STILLWATER, OKLAHOMA.

BULLETIN NO. 60, DECEMBER, 1903.

PLANTING TREES

FOR POSTS, FUEL, AND WINDBREAKS.

INTRODUCTION.

There is much interest among farmers generally concerning the important subject of providing home-grown posts and fuel. The Station has been collecting data and conducting experiments along this line for several years and the following brief notes are believed to indicate the proper methods for Oklahoma generally. The information on which the recommendations are based is not confined to the results obtained on the station farm, but includes that derived from reports of succesful tree planters throughout the Territory and from personal examination of many widely scattered plantings. The station appreciates the kindness of those who have given assistance and thus aided in extending the scope of the inquiry and adding to whatever of value there may be in the results. The station has no tree seeds or trees for sale or distribution but those desiring to purchase any of those mentioned will find no difficulty in obtaining them from local seedsmen and nurserymen.

COLLECTION OF TREE SEED AND PROPAGATION AND CARE OF SEEDLINGS.

The farmer who contemplates planting forest trees must grow his own trees from the seed or buy them from the nursery. Buying the trees from the nursery will incur a greater expense than most of the fa ers in Oklahoma feel able or disposed to bear though often it is more ec omical than growing them. The purchase of the seed to start the t is an item of considerable importance to many. A start can be m quicker if the trees are purchased and set this winter, but if this exp cannot be borne then the seed should be secured and a small nur started on the farm. Farmers can, with little expense, give the c vation and care necessary to grow a few hundred trees in the nursery

A little care and labor will frequently avoid the expense of bu seed of most of the common trees. In all of the older sections of O homa there are many trees under cultivation that produce seed w can be had for the gathering. Many of the native trees are well w cultivating for wind-breaks and timber supply on the farm and a these trees produce seed in abundance. There is little demand for seed, it is difficult to gather, and many kinds will not grow after are one year old. These three conditions are the predominating cau the high price of tree seed.

The following table gives the approximate cost and numbe seeds per pound of the kinds of trees most commonly used in plan for wind-breaks and wood-lots.

VARIETY.	No. of seeds Per pound.	Approx. c Per poun
Ailantus	20000	$0.60
Black Locust	30000	0.40
Black Cherry	4000	0.60
Black Walnut	25	0.05
Box Elder	15000	0.60
Catalpa	20000	0.80
Elm, White	92000	1.50
Hackberry	3000	0.80
Honey Locust	2500	0.40
Osage Orange	10000	0.40
Red Cedar	8000	1.00
Russian Mulberry	200000	2.00
Shell-bark Hickory	50	0.15
Soft Maple	2000	0.70
Sycamore	120000	0.80

COLLECTING, STORING, AND PLANTING THE SEED.

The time for collecting forest tree seed extends from April to November. The seeds should be gathered as soon as they are ripe. The earliest ripening seeds fall as soon as they are ripe. The elm and soft maple ripen their seeds in the early spring and these should be planted the same season and produce plants during the summer. The best success can usually be had with tree seeds that ripen before the middle of the summer by planting them as soon as they are ripe. These early maturing seeds germinate and grow readily, and if well cared for will produce plants a foot or more in height the same season.

The late-maturing seeds will frequently cling to the trees for some time after they are ripe. Ash and box elder seed will frequently cling to the trees long after they are ripe and have become so dry that but few of them will germinate. All of these late maturing kinds should be gathered as soon as they are ripe and placed in storage. The degree of ripeness of the seeds can be determined by the brown and yellow tints of the seed coverings. Seeds that have fleshy pulp like the hackberry and mulberry should be gathered when the flesh of the fruit is ripe. If the flesh is thick it should be removed from the seed before it dries. The large seeds like walunts and pecans can be gathered from the ground after they have fallen from the trees. Seeds that are in pods as the locust should be thoroughly dried, shelled out, and stored. Many of the seeds will be freed from the hulls if well dried and thrashed. Walnuts can easily be hulled by running them through a hand corn sheller. Seeds that are covered with pulp like the mulberry and red cedar should be macerated and the seeds washed out with water and dried before storing or planting.

Acorns and nuts and the seeds of the black locust, honey locust, ash, hackberry, sycamore, kentucky coffee tree, and red cedar should be buried in sand or soil in the fall and left till planting time in the spring. The seed should be kept moist, not wet, and should be exposed to freezing temperature. If spread on a cellar floor most of them will keep well. Seed of catalpa and osage orange should be kept in a dry, cool place, but the latter will do very well if stored in cold, moist earth.

As there are few kinds of tree seed that will germinate well after they are more than one year old, great care should be exercised to have the seed fresh when planting. It may be tested by planting a small quantity in soil in a flower pot or box and keeping them warm and moist till they germinate. By keeping an account of the number that are planted and the number that sprout, a good estimate can be made of the percent of good seed and the thickness that they should be planted in the field. A good deal of information about the age and vitality of the seed can be obtained by splitting a few open and closely examining the seed and the hull. A seed should fill its case or covering and should be fresh and plump when cut open. If they do not fill these three conditions they should be thoroughly tested before planting. In some kinds like the locusts the good seed will sink and the bad seed will float in water. In case of nuts the fresh ones can usually be distinguished by the bright, fresh appearance of the hulls.

Seeds that have thick, woody, or bony coverings require more time to germinate than those that have weak, thin, absorbent coverings. Those with thick shells that have been kept moist and subjected to frost during the winter will usually germinate well without being soaked before planting. Cracking the shell with the hammer or nut cracker is not advisable as there will be more seeds injured than helped in the operation. If they have been well stored and are strong, those with thin coverings should germinate in ten days to two weeks and those with hard shells should germinate in two to three weeks, depending on the kind of seed, its vitality and the conditions of the soil.

Scalding and soaking in lye water will hasten the germination of seed that has not been well stored. If scalding is attempted, care must be exercised to avoid cooking the seed. If a small quantity of boiling water is poured over a large quantity of thick shelled seed the temperature of the water will be reduced to such an extent that no harm will be done. It is a better plan to use warm water and a little more time and be sure that no harm is done. If the seed has been properly stored during the winter and is in good condition, special treatment should be avoided as it is liable to do more harm than good. The seed of the red cedar does not germinate well until the second spring and it is not a good plan to attempt to germinate it before that time.

Nuts and large seed that require storing over winter in moist soil may be planted in the fall in well drained land. Moles, gophers and other field rodents will usually destroy some seed and in extreme cases will destroy most of it. Seeds that are stored in moist soil during the winter should be planted before growth begins in the spring and should not be taken from the soil in which they are stored and allowed to dry before they are planted. If they are dried very much at this time it will weaken them and frequently destroy their vitality. Seeds with thin covering that do not require special treatment to soften the shell should be planted about the same time that other crops are planted in the spring.

Tree seed should be planted and treated about like garden seeds in all respects. The soil should be well prepared and in such condition that cultivation can be carried on from the time the planting is complete. The condition of the soil, size of the seed, and time of planting all have some influence on the depth that the seed should be covered. Seeds should be planted deeper in sandy and loamy soil than in clay land. They should be drilled in rows from three to four feet apart. If the plants are to be taken from the row when one year old the seed should be about three inches apart in the row, but if the plants are to stand in the row for two or three years the seed should be drilled from six to ten inches apart in the row. The soil should be pressed firmly about the seed and the row covered with loose soil.

Seed of the slow growing kinds may be planted in beds about the same as onions and the plants transplanted to the nursery when one year old. This plan requires more labor and may necessitate hand cultivation for the first year. Seedlings that require shading from the hot sun during their first summer should always be started in beds. Many of the evergreens require this kind of treatment, and ash, box elder, elm, and red cedar can be very conveniently grown in a bed for one year and then transplanted to the nursery row.

For bed culture the soil should be enriched and placed in the best possible condition, and the very best of cultivation and care must be given to the plants during the summer. If the bed can be so located that it will be sheltered from the wind a great deal of moisture will be saved for the use of the plants. All weeds and grass should be kept out of the bed with the hoe and by hand weeding. A garden wheel hoe can be used to great advantage in a bed of seedlings.

STARTING FROM CUTTINGS.

Many of the common forest and fruit trees can be started from cuttings with but little more effort than is required to grow them from the seed. The cottonwood and willows are easily and commonly started in this way. Plants grown from cuttings are usually larger and stronger than those grown from seed. Cuttings made from slow growing trees having hard wood, like oak and hickory, do not take root and grow as readily as cuttings made from rapid growing varieties.

The cuttings should be made from one or two year old wood, and stored in moist earth or sand during the winter. They should be cut eight to twelve inches long and the butts laid togther as this will save time in the spring when the cuttings will endure but little exposure.

If a large number of cuttings are set they should be set in rows about three and one half feet apart and six inches apart in the row. The cuttings are set butt end down with about two inches of the top above ground. The soil should be prepared the same as for a good seed bed. Furrows for the rows are thrown out with a turning plow and the cuttings laid along the side of the furrow in a slanting position or stood perpendicular and the soil thrown in and firmed about the base of the cuttings by tramping. The cuttings can be set more rapidly and the soil firmed about them better when they are set slanting and as this form of setting seems to have no bad features it is usually employed. Cutting may be set with a spade as follows: Sink the spade into the soil and pry it forward to open the soil. Set one or two cuttings into this opening and withdraw the spade, and firm the soil by tramping. This is a slow process and is used only when a few cuttings are set at a time. In very mellow or sandy soil the cuttings may be pushed into the ground and the soil pressed about it by tramping. These methods can be modified to suit the convenience of the planter but whatever method is used the soil must be pressed close about the base of the cutting.

CULTIVATION IN NURSERY.

The cultivation given while the plants are in the nursery should be shallow, and frequent enough to keep the ground free from weeds and the surface well pulverized. Frequent, shallow cultivation will do a great deal to prevent the loss of water from the soil by evaporation from the surface. The cultivation should be continued from early spring till the growth has stopped in the fall. The ordinary corn cultivators are good tools to use for this work.

The faster growing trees should be transplanted from the nursery row to their permanent positions when one year old. The slower growing kinds may be planted thick in the nursery and at the end of the first year transplanted to new rows and given more room and when two or three years old transplanted to their permanent positions. Trees two or three feet high are sufficiently large to transplant to their permanent position in the wind-break or wood lot. The nut bearing trees and the evergreens may be transplanted while much smaller. The trees will grow more rapidly after they are transplanted than while in the nursery row and the work of transplanting can be done with less expense while the trees are small.

If the trees cannot be transfered direct from the nursery to the field they should be heeled-in in good shape to keep them in good condition. If the soil is dry the roots of the plants should be puddled in thin mud before they are heeled-in. A good method of heeling-in trees is to dig a trench or bed about a foot deep. Distribute the trees along one side of this and cover the roots well with damp soil. Place another layer of trees against the soil covering the last layer and cover the roots as before. Continue this process till all the plants are heeled-in. Care must be exercised to cover the roots well and work the soil in around the plants.

PREPARATION OF THE LAND AND TRANSPLANTING THE TREES.

The land for the permanent planting should be prepared the same as for orchard planting. The trees will grow better if the land has been in cultivation for a few years and is in a good state of cultivation. The land should be stirred deep with the turning plow and harrowed down smooth before the trees are set. The land should be free from weeds and grass for after the trees are set it will be more difficult to destroy such pests. If the top soil is shallow and is underlaid with a clay subsoil the land may well be subsoiled when plowed. The subsoil thrown up by the subsoiler should fall back into the furrow and be covered by the plow and not brought directly to the surface. The same system of cultivation advised for the nursery should be followed in the permanent planting.

In transplanting the trees should be set the same depth or a little deeper than they stood in the nursery row. The roots should spread in their natural position and damp soil should be pressed firmly about the roots and trunk of the tree. It is a good plan to shake the tree while the soil is being thrown in around it to make sure that there are no open spaces under the roots. It requires but a little time to work the soil in well around the roots and yet this very important point is very frequently neglected and causes the death of the tree.

The roots are unavoidably pruned when the trees are dug and usually require no further attention in that direction. The tops should be cut back when the trees are set or soon after that time. Some of the kinds that are inclined to fork and branch like the soft maple, catalpa, and black walnut may be allowed to grow for a year in their permanent positions and then the tops cut back to the ground. Trees treated in this way grow better trunks and better tops than those that are allowed to continue the growth of the original top. Repeated cutting back will cause the trees to sprout badly at the base. All sprouts and suckers should be removed while young and tender.

SEASON OF TRANSPLANTING.

Fall and spring setting each have their advantages and their corresponding disadvantages. Trees set in the fall have the advantage of any root growth that may take place in the winter. The soil will settle around the roots in the winter and be in better condition for growth in the spring. More time can be given to the work if the trees are set in the fall and early winter and the trees will usually be in better condition to pass the winter if planted than if heeled-in. Spring setting gives more time for the preparation of the land for the setting. Plants heeled-in can be better protected from the rabits and mice than trees set in the fall. Good results can be obtained by either fall or spring setting if the work is well done and the ground is in good condition for the work. More depends upon the weather than upon the season in which the work is done. If there is plenty of rain in the fall to put the ground in good condition for the work the trees should be set in the fall. If there is not sufficient rain in the fall to prepare the land for the trees, planting should be postponed till spring or until enough rain has fallen to prepare the land for the work. There are many warm spells during the winter in which this work can be done.

WIND-BREAKS.

The most disagreeable feature of the climate of Oklahoma and the neighboring states is the great amount of hard wind. A planting of trees around the house and farm yards does much to diminish the effect of the wind and increase the comforts of farm life. Such plantings may also be of great value in providing shelter for stock. The comforts and conveniences created about the farm home by a good wind-break are so commonly recognized that no attempt will be made to point them out here. In fact the benefits so derived are so commonly appreciated that a great many farmers plant their orchards so they will serve the double purpose of an orchard and a wind-break and their greatest value often lies in the latter office.

The orchard will fill its place in the economy of the farm as an orchard if well cared for and should not be used permanently for a wind-break. There are few of the fruit trees that are sufficiently hardy to make a good wind-break and endure the exposure to which they are there subjected and still bear even a fair crop of fruit. It is a far better plan to set the orchard in a block form and plant rapid growing forest trees for a wind-break. The orchard will be greatly benefitted if it is protected from the southwest wind by a belt of timber. A dry wind blowing across a field dries the surface of the soil very rapidly and carries away a great deal of soil moisture. A wind-break checks the force of the wind and in this way saves a great deal of moisture for the crop that is on the land. A wind-break formed of trees draws large quantities of water from the land on which it grows but this loss is more than offset by the amount of water saved in the adjacent field or orchard.

Orchard trees sheltered by a wind-break or shelter belt of timber grow in much better form and are not leaned to the north by the wind. The trunk of the tree will be better shaded by the top and thus many cases of sun-scald and borers will be avoided. Pruning may counteract the effect of the wind to some extent but a good wind-break is far more effectual. Trees sheltered by a belt of timber or a grove are not broken like those more exposed, and carry a greater percent of their fruit to maturity. It is not an uncommon experience for three-fourths of the fruit to be shaken from the tree before it is mature. The codlin moth is the cause of a great deal of the windfall fruit in Oklahoma but the hard wind has about as much immature fruit to its credit. A good wind-break will reduce the amount of windfall fruit and will make it possible to do better work in spraying and thus check the ravages of insects and diseases on the fruit and foilage. Good spraying cannot be done in a hard wind.

Some fruit growers object to a wind-break for an orchard on the ground that it is a harbor and breeding ground for insects and diseases, and that the row of trees next to the wind-break suffers for the water which has been drawn from the soil and used by the trees forming the wind-break. If the wind-break is a harbor and breeding ground for insects and diseases it is a fault of the care and cultivation given it. It should be cultivated and cared for the same as the orchard and any insects and diseases injurious to the orchard should be combatted the same as in the orchard. The insects and diseases that are most common in the orchard seldom attack the kind of trees used for the wind-break, and the reverse is also true. If the wind-break robs the outside row of trees of food and water it is a fault in its location. A space of thirty to forty feet should be left between the wind-break and the first row of fruit trees.

The ideal wind-break is a belt of timber or a grove of trees taller than the trees in the orchard. Such a shelter belt cannot always be grown on the average prairie farm and a hedge or at best a narrow belt of timber may answer the purpose. If possible, this planting should be completed two or three years before the orchard is set, so the young fruit trees may be protected from the hard wind when they are first set in the orchard. The trees that are to form the wind-break may be set in the form of a hedge, or far enough apart in the row so they can develop and make good trees. Both plans are good and make good wind-breaks when suitable kinds of trees are used. The amount of land that can be devoted to this purpose should be the principal point in deciding the formation of the planting. The hedge row form of wind-break requires a plant with a thick growing top like the russian mulberry, and osage orange. Seedling peach trees are some times used to good advantage for this purpose. The plants should be set about one to two feet apart, and should be well cultivated to encourage as great a growth as possible. These trees make a very dense top when in full leaf and the Russian mulberry and osage orange are not commonly attacked by diseases and insects that live upon orchard trees and fruits. The Russian mulberry is the best tree, commonly grown in Oklahoma, for such purposes.

If there is room for a more extensive planting it is a better plan to set the trees four or five feet apart in rows four feet apart. In this form of planting the trees can be cultivated for a few years and made to supply posts and wood for use on the farm. The outside row of trees should be left unpruned or some low, spreading kind of tree should be planted with the tall growing varieties. The tall growing trees if pruned to grow good posts and poles will not make a good low windbreak. If the two outside rows are not pruned they will make sufficient undergrowth. The Russian mulberry and tamarisk are two of the best low spreading trees to use in a mixed planting of this kind. Seedling peach trees are some times used for this purpose to good effect. Elm, catalpa, soft maple, and black locust are the best of the tall growing trees used for a wind-break in Oklahoma.

A few farmers are growing good wind-breaks composed of cottonwood, black locust, and plum trees. The cottonwoods are planted twelve to sixteen feet apart and two or three black locusts between. The plums are planted in another row outside the row of larger trees. Either the wild plums or some cultivated varieties can be used. This combination can seldom be used successfully on upland. On loam and clay lands the black locust, soft maple, elm, catalpa, and Russian mulberry should be used. The black locust and Russian mulberry make a very good combination. The soft maple is not adapted to close mixed planting and when it is so planted provision should be made for its removal in a few years. The other trees named may be planted in mixed or pure plantings and will usually give good results.

PLANTING FOR A WOOD LOT.

A wood lot is a planting of trees for the purpose of growing wood. The aim of the planter is to grow the most wood possible in such form, and size that it can be used for fencing and fuel, with the least expenditure of time, money, and labor. Inasmuch as the trees are expected to produce wood of marketable size within the life time of the planter, only the fastest growing trees can be used. In this climate the time required to grow trees to post size can be greatly reduced by care and cultivation, during the early life of the planting. Usually the only money expended in growing a few acres of timber is the original cost of the seed, or seedlings and the taxes on the land. The amount of time required to grow wood of valuable size makes it desirable to use all reasonable efforts to increase the rate of growth. The first thing of importance is the quality of soil on which the planting is made. Good soil is most valuable for wood production as well as for the common farm crops. Small nooks and patches in creek bottoms that are difficult to tend in the regular farm crops answer for wood lots very well. Hillsides, washed land, knolls and waste land too poor to cultivate in farm crops should not be planted with trees with the hope of securing good timber in a few years. The dry summers and the extreme barrenness of some such land places wood production thereon practically out of the question. It would require more than the ordinary lifetime for trees set on such land to bring the fertility up to the standard required to produce good wood growth. Stony land that cannot be cultivated but contains a fair quality of soil will grow good timber.

Trees grown for wood should produce long trunks free from branches. There are two ways of growing such trees; 1st constantly pruning off the branches, and 2nd planting the trees close together so that after four or five years the trees will prune themselves. The latter method is used in wood lot planting. In close planting the growth of the top is augmented and the growth of the side branches is checked, and after a few years no pruning is necessary.

Trees set far enough apart to give plenty of room for cultivation will require pruning for a long time. The tops cannot shade the ground sufficiently to prevent the growth of weeds and grass, and the annual mulch of leaves and twigs will not be heavy enough to produce a forest soil. The best results have been obtained by setting the trees four or five feet apart each way. The trees are pruned as long as cultivation is continued which should be until the trees have possession of the land to the exclusion of other plants. When the trees can shade the ground well enough to prevent the undergrowth of weeds and grass, cultivation may be discontinued. Trees with small or pendant leaves like the black locust and cottonwood cast a poor shade and are slow to prevent the undergrowth of weeds; these varieties should be cultivated until they are quite large. The broad-leaved trees like the elm cast a good shade and will prevent the undergrowth of weeds in three or four years and then are able to take care of themselves. Mixed planting does not give as good results as the foregoing would seem to indicate. There is so great a difference in the hardiness and rate of growth of the different kinds of trees set, that a mixed planting soon becomes a pure planting or at most contains but two or three of the strongest varieties. The few stunted trees of the weaker varieties that do survive for a few years seldom make good trees when the larger trees are cut. The varieties of trees most commonly grown for posts and fuel are capable of reproduction by sprouts from the stump and roots, and this crop of second growth trees will be better than the old stunted trees.

The trees that are set in the wood lot on the farm are not set for the purpose of growing timber for lumber, and all the trees will be cut before they are large enough for saw logs and many will be cut as soon as they are large enough to make good posts. The trees of the fastest growing varieties will be young when cut and will sprout well, if the cutting is done in the winter. The stumps should be cut with a smooth, sloping surface to prevent rot as much as possible. Post timber should be cut in the winter and seasoned thoroughly before it is placed in the ground.

TREE PLANTING AT THE EXPERIMENT STATION.

The first planting of trees for the purpose of a wood lot on the experiment station farm was made in the spring of 1898. This planting consisted of three plats designated as numbers 35, 36, and 37. Trees one year old were used except in the oaks, walnuts, and pecans and seeds of these trees were planted in the position in which the trees were desired in the planting. The trees were placed four feet apart each way and were given clean cultivation for the first three years.

Plat No. 35 contained 1599 catalpas, 270 black cherries, 270 bur oaks, and vacant places were left for 1599 Russian mulberries, which were never planted. In December 1903 there were 1538 catalpas, 188 black cherries, and 142 bur oaks living.

Plat No. 36 contained 1500 white elms, 1500 soft maples, 600 bur and red oaks, and 330 black locusts. In December 1903, 329 black locusts and 260 oaks were living. Part of the elms were taken out but less than one percent have died in the plat. Part of the maples were also removed and all of those left in the plat are now dead. Seventy five per cent of the dead maple trees were infested with flat headed apple tree borers at the time of their death.

Plat No. 37 contained 2558 red maples, 511 black birches, 374 pecans, and 320 white ash. In December 1903 there were 310 white ash, 76 pecan and 126 black walnut trees living. The black birch trees were all dead, root and branch. The red maple trees are all dead but about one half of the stumps are still alive and sent up sprouts last summer. These sprouts are very weak and practically worthless.

In the spring of 1900 another planting of forest trees was made, consisting of thirty four plats. The trees used in this planting were white ash, box elder, catalpa, white elm, black locust, honey locust, and soft maple. Plat 1 to 24 inclusive and plat 27 are mixed plantings containing from three to seven kinds of trees systematically arranged. Plats 25, 26, and 28 to 34 inclusive are pure plantings. All the trees were seedlings of one season's growth when set. The black locust is the only tree that has made a better growth in the mixed plantings than in the pure planting. It is much the fastest growing tree in the list and in every case has proved an injury to the trees set next to it. This planting is not old enough to show final results and may be reported upon at some future time. All of the information that could be obtained from this planting at this time is given in the discussion of the different kinds of trees.

Ash: (White Ash, American White Ash.) This tree is valued more for its beauty of form and foliage than for its wood production. It attains a height of fifty feet and a trunk diameter of two feet. It grows very slowly for the first four or five years after which time it grows more rapidly. The top of the tree is narrow, with a main central stem forming a clean straight trunk. The wood is heavy, hard, strong, and becomes brittle with age. It is not durable when placed in contact with the ground but is a very good fuel.

Box Elder: The box elder grown on moist bottom land often attains a height of forty to fifty feet and a trunk diameter of two feet. In this situation it is a rapid growing tree with a broad top and casts a good shade. It is a failure when planted on the upland. It is frequently attacked by borers and leaf eating insects. The wood is light, soft, not strong, rots quickly in contact with the ground, and is a very poor fuel.

Catalpa. The catalpa is a rapid growing tree, often attaining a height of sixty feet and a trunk diameter of three to four feet. It grows best on a deep rich soil and a satisfactory growth can seldom be secured on light, thin soil. In a pure planting the trees will completely shade the ground in three or four years. It sprouts well from the stump when the trees are cut in the winter. The wood is light, soft, not strong, coarse grained, and extremely durable when placed in contact with the ground. It is poor fuel but makes first class posts and fencing material.

There are two species of Catalpa, *Catalpa speciosa,* commonly called Hardy, or Western Catalpa, and *Catalpa Catalpa,* commonly called Southern Catalpa. The Western catalpa is a tall upright tree with few large branches. It requires close planting to develop a good trunk. The Southern catalpa is a low growing tree with a broad top. These characteristics are influenced by soil and location. On poor soil in open plantings both kinds form low, branching heads. The Western catalpa as a rule produces only one to three seed pods in a cluster, and each pod is from fourteen to twenty inches long and one half inch in diameter. The seeds are large, broad, and about the same width the entire length. The filaments at the end of the seed are parallel or spreading. The bark of tree is thick and deeply furrowed. The Southern catalpa produces from four to eight pods in a cluster, and each pod is from eight to ten inches long. The seeds are small and tapering at the end. The filaments are drawn together and are sometimes twisted. The young branches of one season's growth are enlarged at the joints. The bark of the tree is thin and scales off in large thin scales.

White Elm (American Elm.) This is a large tree and when full grown often attains a height of one hundred feet and a trunk diameter of six feet. It forms a round or broad and spreading top. It is a rapid grower and adapts itself well to all kinds of soils. The wood is hard. heavy, strong, tough, difficult to split, not durable in contact with the soil. It makes a good fuel when it is reduced to such form and size that it can be used, but is very difficult to work. This is the best shade tree that has been planted in Oklahoma. The tree is hardy, seldom attacked by insects and diseases and casts an ideal shade. It is a first class tree to plant about the house and yard but is only a second class tree for posts and fuel.

Hackberry. The Hackberry attains a height of sixty to seventy five feet and a trunk diameter of three to four feet. When planted in good soil and given cultivation it is a rapid growing tree but is capable of living when set in the driest and poorest soil. As a cultivated tree it is very much like the elm but it more hardy and the wood is less difficult to split. The wood is heavy, rather soft, not strong, good fuel, not durable when placed in contact with the soil. It is a good tree for planting around the house and yard and for a wind-break.

Black Locust, (Yellow Locust.) This tree grows rapidly and attains a height of sixty feet and a trunk diameter of three feet. The top is of good form with a main central stem when grown in close plantings, but it frequently branches and forms a large round head when grown in the open. It grows fastest when set in mixed plantings but does not form as good a trunk. It usually grows more rapidly than the other trees and branches and spreads over the tops of the other trees. It casts a poor shade and is slow to occupy the ground to the exclusion of other plants. It sprouts vigorously from the stump and roots broken by the plow or spade. The wood is heavy, exceedingly hard, strong, and durable when placed in contact with the ground. It is a very good fuel.

This tree has been extensively planted as a timber tree in the United States, but its cultivation is now generally abandoned in the older states on account of the locust-borer. The locust-borer has been so destructive of this tree in Kansas that it is not planted there now to any great extent. The central and western part of the state was at one time supposed to be exempt from the borers but they have gradually spread over the entire state. So far as can be learned this borer has not appeared in Oklahoma, but it is only a question of a few years till it will be found in abundance. Although thorough search has been made no reports have been found which indicate that the locust borer ever works on fruit trees.

Honey Locust. This tree attains a height of fifty to sixty feet with a trunk diameter of three feet. It is not one of the most rapid growers but is capable of making a good growth under the most adverse conditions. It is liable to suffer when transplanted and should be carefully handled at that time. It stands pruning remarkably well and is often used as a hedge plant. It casts a poor shade and is slow to occupy the ground to the exclusion of other plants. It requires thick planting to form good trunks. The wood is heavy, hard, strong, very durable in contact with the ground and is a good fuel.

Soft Maple. (Silver Maple.) This tree often attains a height of sixty feet and a trunk diameter of four feet, but the mature trees are usually much smaller. It grows rapidly and forms a broad, round top. This tree responds very quickly to cultivation and suffers if neglected. In close planting it grows rapidly for a few years and then dies out badly. The trees suffer if the roots are exposed to any extent in transplanting. Winter and spring setting have given the best results. The trees are frequently destroyed by borers and the foliage is attacked by insects and fungus diseases. The wood is soft and easily broken while green but becomes hard and strong when well seasoned. It is light, poor fuel, and rots quickly when placed in contact with the ground.

The value of this tree has been over estimated in Oklahoma and it has been planted more than its true value warrants.

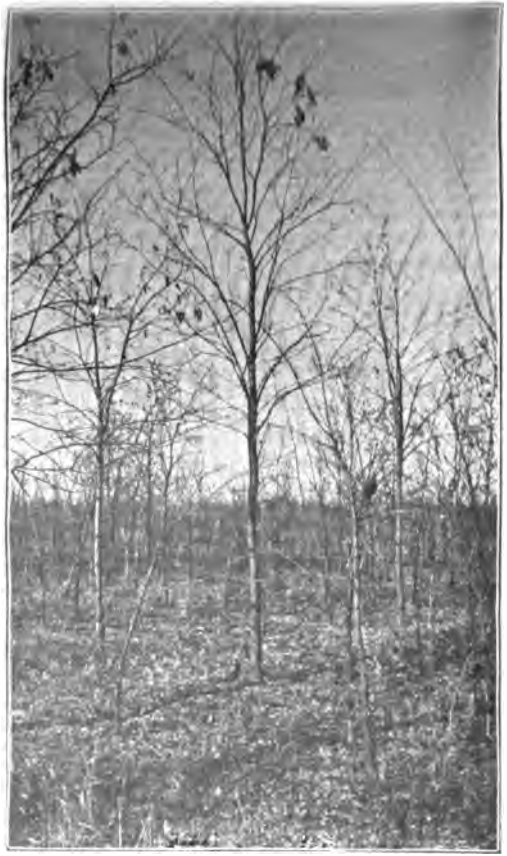
Osage Orange. (Bois d' Arc.) This tree attains a height of forty to fifty feet and a trunk diameter of eighteen inches. It is a rapid grower on moist bottom land but is not adapted to light, upland soil. It sprouts vigorously from the stump and broken roots. The wood is heavy, hard, strong, flexible, good fuel, and very durable in contact with the ground.

The Russian Mulberry is a medium sized tree introduced into the United States from Russia and it is not known how large it will grow in Oklahoma. Trees fifteen years old and twenty feet high are not uncommon. The tree branches profusely and forms a very dense top and a poor trunk unless it is constantly pruned. It is very hardy, grows rapidly and is a first class tree for a wind-break. The wood is heavy, hard, strong, and is a good fuel. Its durability in contact with the ground has not been thoroughly tested but the indications are that it is as durable as the Red Cedar.

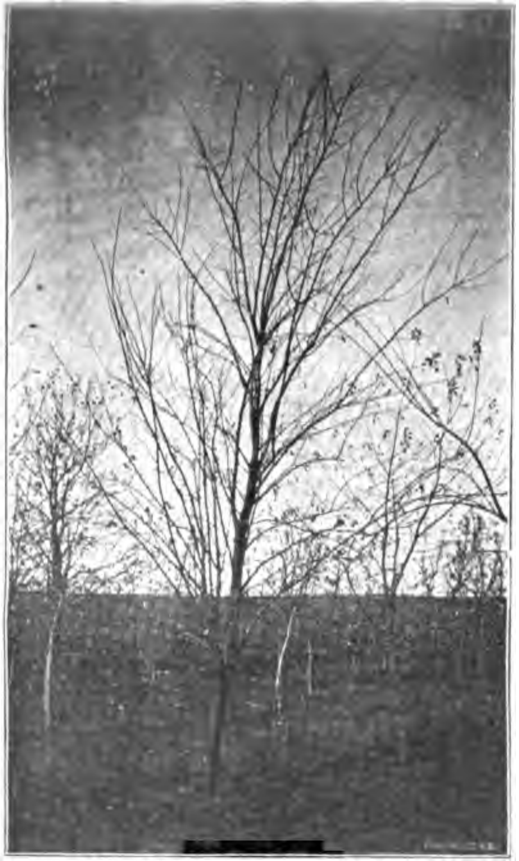
Sycamore. This is the largest tree east of the Rocky Mountains. It often attains a height of one hundred feet and a trunk diameter of ten feet. It grows rapidly and forms a good top. It is a very good tree for ornamental planting. The wood is of little value and hard to work.

Black Walnut. This is a very large tree sometimes attaining a height of one hundred feet, and a trunk diameter of eight feet. It is of slow growth and is adapted to planting only on rich bottom land. It is difficult to transplant. The wood is heavy, hard, strong, easily worked. and durable in contact with the ground. It is good fuel but is too valuable to use for that purpose.

O. M. MORRIS,
Horticulturist.

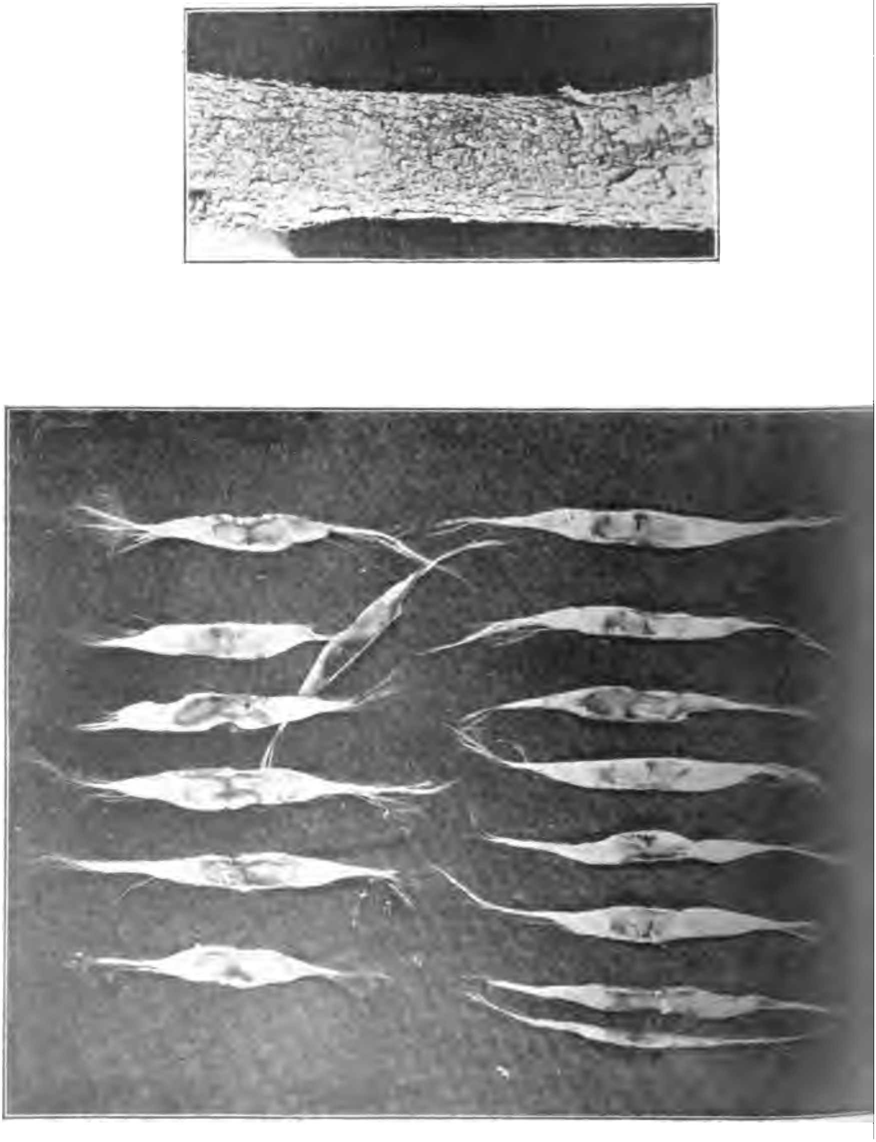


Thick Planting.

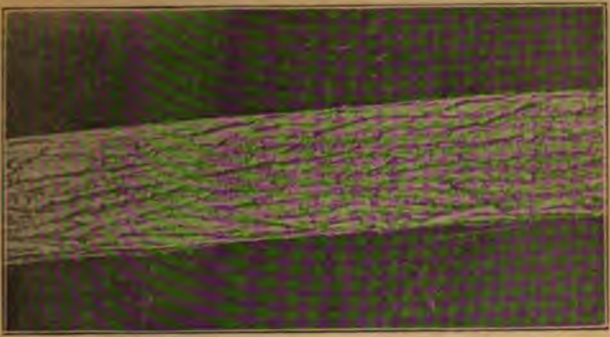


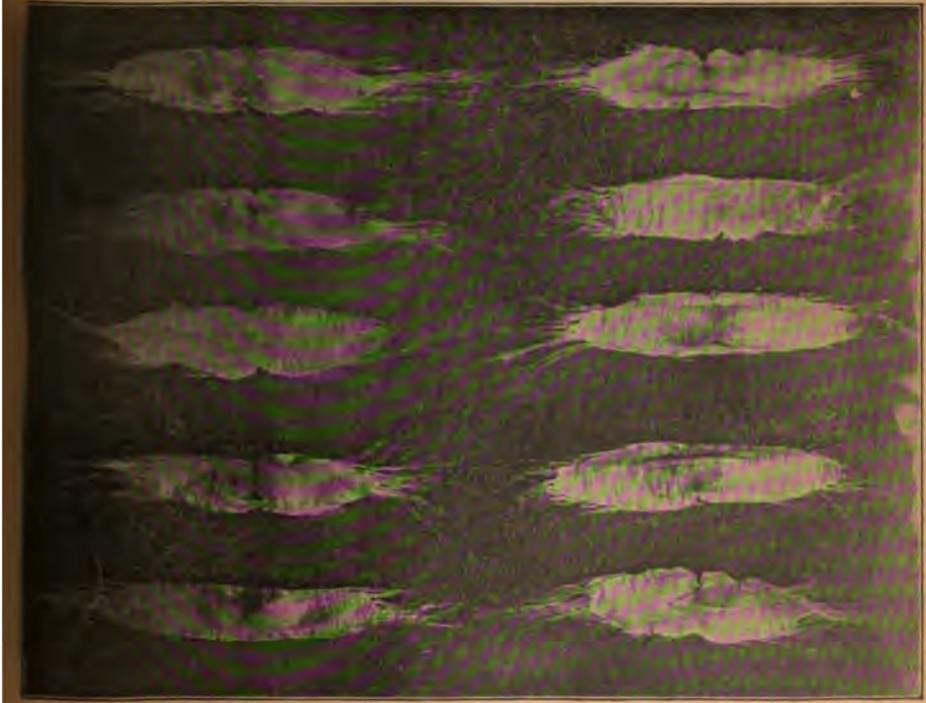
Thin Planting.

BLACK LOCUSTS.



Character of bark and seeds of Southern Catalpa. (**Cut of seeds from Kansas** Station.





Character of bark and seeds of hardy or Western Catalpa.
(Cut of seeds from Kansas Station.)

REPORTS OF
THE FOREST PARK RESERVATION COMMISSION
OF NEW JERSEY

FOREST PLANTING
IN NEW JERSEY

BY
ALFRED GASKILL
State Forester

DIVISION O
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The Forest Park Reservation Commission.

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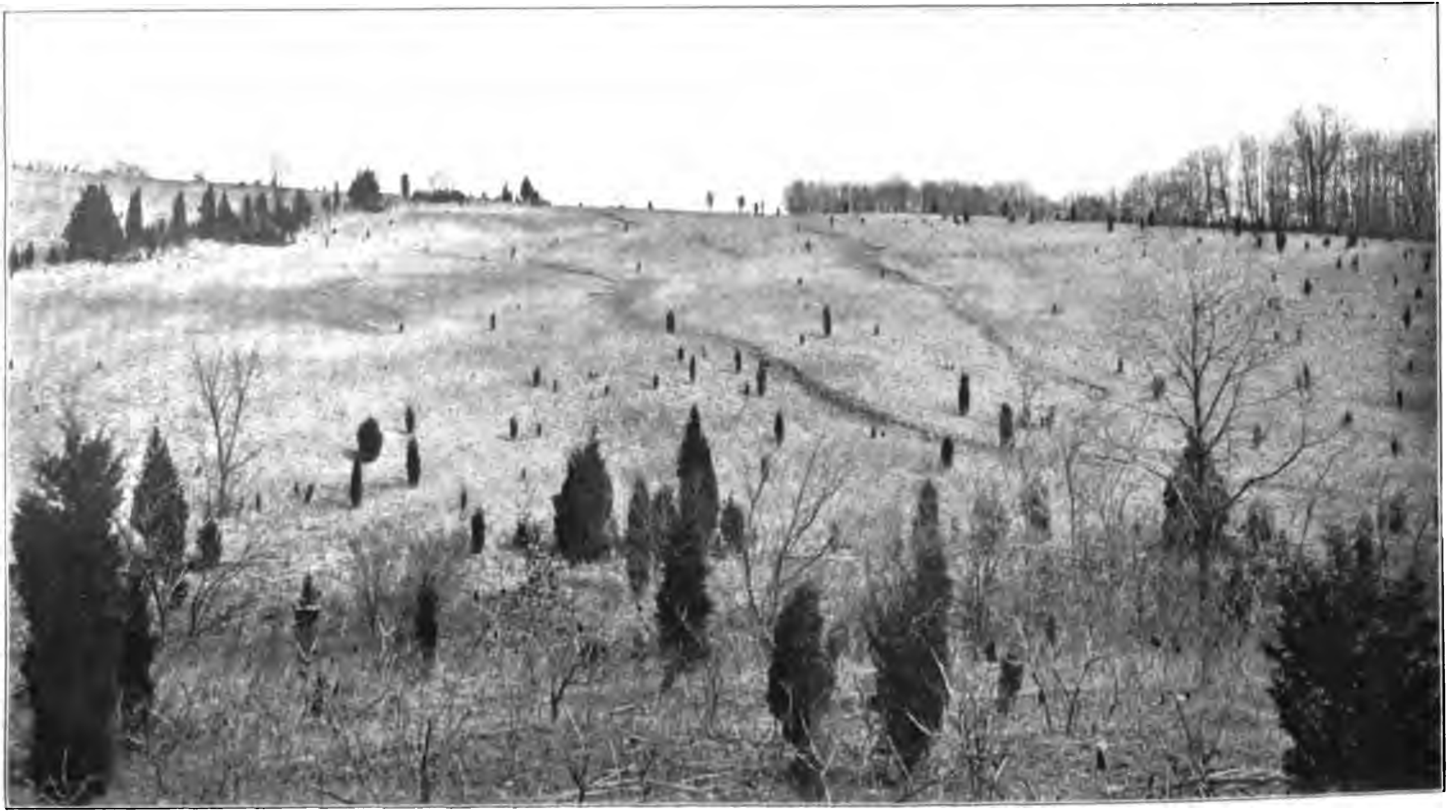

FIG. 1. The kind of land that should be restored to forest. It can be farmed but washes badly and will do better in trees. The scattered evergreens are volunteer red cedars.

FORESTR
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STATE AID IN FORESTRY

The Forest Commission wants to assist farmers, and all woodland owners, to practice forestry. See offer on page 28.

Forest Planting in New Jersey.

THE NEED OF PLANTING.

The Forest Commission lays little stress upon forest planting because the State's woodland area is now as great as it should be, and because **it is easier, cheaper, and,** for the present, **better to make good forests out of** the abused and neglected **natural forests.** To do this requires, in most cases, no outlay; simply protection against fire and proper thinnings at the proper time are enough. The result will rarely be as good, silviculturally, as from a planted forest, but the crop will come quicker and it will cost less.

Where planting is proper. There are places and conditions, however, that justify planting; they are where land cleared for cultivation or pasture is found unfit, or is no longer wanted, and where forest is desired for pleasure or to simplify the administration of an estate (Fig. 1). In the first case the land, being fit for nothing but forest—**true forest soil,** would naturally have a low value; a plantation therefore should be expected to yield a profit. In the latter cases satisfaction rather than profit would be the object.

Underplanting, or filling gaps, in woodlots is often advisable. The procedure is the same as in open plantations but greater care in the choice of species is required on account of the deficient light afforded—see tolerance, p. 9.

Shade trees not considered. The present discussion deals solely with the production of timber. Beauty and shade are entirely apart.

NO QUICK RICHES.

Intending forest planters are reminded that an investment in forestry will yield returns in proportion to the skill and wisdom that underlie it; that the income from a plantation may equal from four to eight per cent., compound interest, yet can rarely be more because there is a limit to the rate at which trees grow. **Sure, steady, moderate returns,** rather than quick riches are always the foresters aim. See p. 25.

CLIMATE AND SOILS.

The climate of New Jersey is everywhere suitable for many kinds of trees, and highly favorable to some. No part is too hot, too cold, or too dry to produce vigorous trees.

Its soils, on the contrary, are very diverse, and make necessary a careful adaptation of species to local conditions. No part of the upland, except the beaches and about 25,000 acres on "The Plains," is incapable of supporting a forest of some kind. Even the sandy soils of the pine section are less sterile than is commonly supposed. Solely for the guidance of tree planters the soils of the State may be divided into six classes. See p. 14.

WHAT TO PLANT.

When a forest is founded by Nature one wisely uses what he finds; when a forest is to be planted the aim should be to **choose the best** for given conditions.

Pure or mixed forests? Many foresters advocate mixed plantings (two or more species) upon the ground that that is Nature's way, that one species helps another, that insects and disease do less harm than in pure (one species) forests. All these arguments have weight, yet most authorities now favor comparatively small groups of a single species, each group representing the fittest tree when climate, soil, markets and all other factors are considered. Under this rule pure forests of several hundred acres may be established. For these reasons, and because it is hard to determine the character and proportions of a mixed forest without a careful study of local conditions, **only pure forest** plantations are here **considered.**

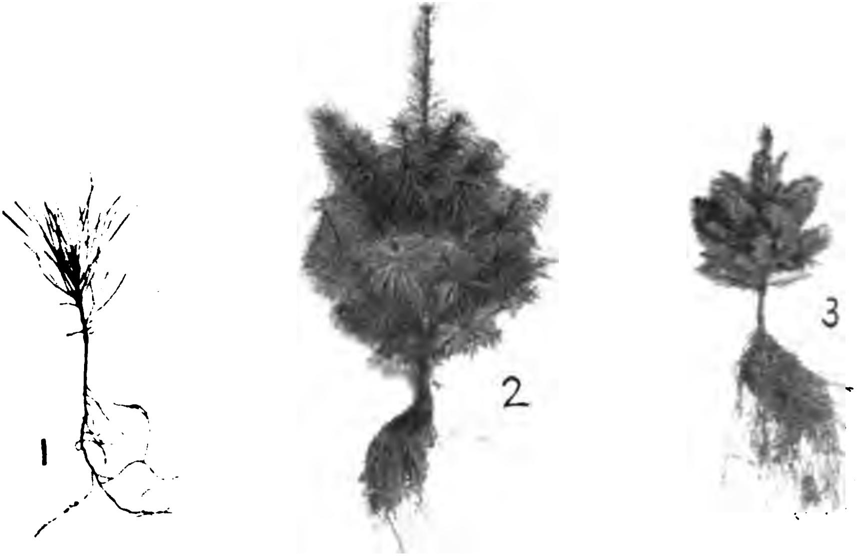


Fig. 2. TREES FOR FOREST PLANTING.
1.—Two-year-old Pine Seedling: It is healthy but not sturdy and has long slender roots. 2.—Four-year-old Pine Transplant: Vigorous, sturdy, well-compacted roots. 3.—Four-year-old Spruce Transplant: Not so large as the pine but capable of making a good growth.

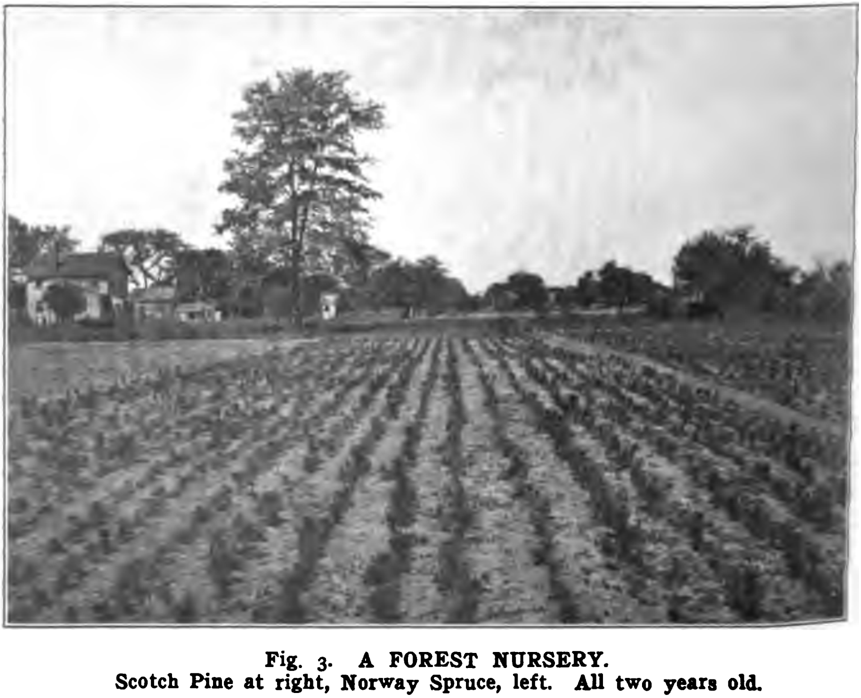


Fig. 3. A FOREST NURSERY.
Scotch Pine at right, Norway Spruce, left. All two years old.

Evergreens or deciduous trees? An impression prevails that black walnut, white oak, black cherry, hickory, etc., are the most profitable trees to grow because their woods bring high prices. If the available land is suited to these trees it may be so used, yet such trees grow well only on strong agricultural soil of which there is, or soon will be in this State, none to spare. If we deal with true forest soils the conifers or **evergreens will yield more** per acre and year **than any others.** Pine of some sort is the world's most valuable wood, and always will be, bebecause it satisfies most needs. Pine is best for planting in South Jersey because it is suited to the sandy soils, and it is best for planting in North Jersey because it produces more wood in less time than any deciduous tree. Spruce and fir are almost as valuable, and may be used as variants.

Tolerance. In forest planting, as in every branch of silviculture, the innate qualities of each tree species with respect to sunlight must be considered. Some; pines, ash, cottonwood, will endure little shade from other trees; they are called light-requiring or intolerant: others; spruce, fir, beech, are less particular and are called shade-enduring or tolerant (of shade). Tolerant trees when well grown always have more branches than intolerant trees, but more of them can thrive on a given area. An intolerant species must never be planted where it will lack light.

Quick growers. By all means use the species that will give quickest returns, but bear in mind that rapid growth is usually a response to stimulation through fertile soil, abundant moisture, excess of warmth, etc. Cottonwood grows rapidly in moist soil; it will fail where it is dry. Catalpa requires warmth, fertility and moisture for its full development. White pine thrives on a medium soil, yet on poor soil may fall behind pitch pine.

Nut Trees. Nut culture is not forestry, but a branch of horticulture. A tree developed for fruit has too much crown to produce good lumber; one grown tall and straight for lumber has too little crown to yield much fruit. Dismiss, therefore, all thought of combining the two crops. Let fruit (including nuts) be grown where that is likely to be profitable and the trees can be given the care that they need. Trees for lumber are satisfied with poorer soil and much less care. Of course, fair crops of nuts may be, and often are, produced by forest trees.

Choice of Species. For most situations in New Jersey let the choice be limited to the following species. Their qualities and values are known; others may be as good, but are less sure.

White Pine. (Pinus strobus.) This is unquestionably the most promising tree for forest planting. Its silvical qualities adapt it to any but the poorest soils, its growth rate is high and tolerance considerable. All this results in a large timber production at a comparatively early age. A yield of 30 M board feet per acre at 50 years is not excessive. The one drawback is that a dangerous disease threatens the species. For the present it is recommended that white pine be planted in moderate quantity only.

Red Pine or Norway Pine. (Pinus resinosa.) A tree that in many ways promises to be quite as valuable as white pine. Its wood is a little heavier, but is also stronger. The tree is not so rapid a grower, and in maturity the forest is less dense, but the individual trees are apt to be taller and their stems clearer. A yield of 30 M board feet per acre at 60 years may be expected. The tree has no dangerous enemies.

Scotch Pine. (Pinus sylvestris.) This is the common pine of Europe. It thrives on good soil, and makes a fair growth on the poorest. It is especially vigorous when young. The wood is practically like that of red pine, consequently sure of a market in any form. A yield of 25 M board feet per acre at 50 years should be obtained from a plantation established under fair conditions.

Austrian Pine. (Pinus laricio.) A much heavier-set tree than any of the others, and generally appreciated for its good looks. The species is adaptable to poor soils, especially limestone rocks. The stem cleans about as well as white pine. The yield is somewhat less.

Pitch Pine. (Pinus rigida.) The common pine of South Jersey and of the mountain ridges in North Jersey. It is by no means the valueless tree that many imagine. The wood is resinous, but strong and fairly durable, and is in demand always for construction lumber and box boards. The rate of growth depends largely upon the soil. On poor sand it is naturally relatively slow, but its great value is that it is highly fire resistant. The tree should be fostered wherever found and may be planted on land too poor for other species, or where the fire risk continues.

Loblolly Pine. (Pinus taeda.) A tree native of the Southern states, where it grows with marvelous rapidity. Recent experiments indicate that it can be grown successfully in South Jersey and in sheltered situations, but for the present it is recommended only for experimental planting.

Shortleaf Pine. (Pinus echinata.) The species found in Central and South Jersey, usually mixed with oaks, on the better soils. It is comparable in most respects with red pine, and in South Jersey may be planted as an alternative.

Norway Spruce. (Picea excelsa.) The common spruce of Europe. A tree of great economic value because its wood is sought for paper pulp as well as for lumber, and because, by reason of its tolerance, it is able to grow in close stands. It requires fairly strong soil, and thrives on ground much moister than is acceptable to any of the pines. (It will not grow where the ground is constantly wet.) This species is preferable to any of the native spruces. The average yield on suitable soil is about 30 M board feet at 60 years.

Douglas Fir. (Pseudotsuga taxifolia.) Stock from Rocky Mountain seed only should be used. That from Pacific Coast seed is apt to be frosted. The tree grows at about the same rate as the Norway spruce, though the stands are not quite so dense. The wood is tough and strong, comparing favorably with red pine or shortleaf pine. From the best information available, a yield of 25 M board feet at 60 years should be obtained on fair soil.

European Larch. (Larix europaea.) A tree especially valuable on account of the durability of its wood. Unlike the Eastern American species, it requires well drained as well as fairly strong soil. It is advised for planting where the extinction of chestnut is likely to create a demand for posts, poles, etc. A yield of 20 M board feet at 60 years may be expected.

Balsam, Fir. (Abies balsamea or Abies pectinata.) The first is the native species; the second the European. They are valuable on account of their adaptability to moist land, high degree of tolerance, and production of a wood that is about as useful as spruce. In many situations the plantations may be made with a view to marketing Christmas trees, for which either species is preferred. A mixture of balsam and spruce with a view to removing the former at 10 or 15 years, leaving the latter to grow to timber size, would often prove advisable.

Cottonwood. (Populus deltoides.) The so-called Carolina poplar, a tree of very rapid growth on moist soil—of little value where it is dry. It should be planted not less than 10 feet apart, either pure or mixed with a more tolerant species suited to the same conditions. A yield of 25 M board feet in 30 years may be expected.

Red Oak. (Quercus rubra.) Probably the most promising deciduous tree for soils of moderate fertility. Its wood has a recognized value for many purposes, and apparently is the most available for railroad ties. A yield of 20 M board feet, or 700 railroad ties, per acre in 40 years is possible.

Tulip Poplar. (Liriodendron tulipifera.) The most valuable soft wood deciduous tree. It requires strong, well-drained soils, but when planted in such situations grows vigorously. As the wood is used generally for cabinet work and fine box boards, trees less than 16″ diameter, breast-high, have comparatively little value. Properly made plantations should yield 30 M board feet per acre at 50 years.

White Ash. (Fraxinus Americana.) This tree grows vigorously on ground too wet for cultivation. Its wood is in constant demand on account of its toughness and elasticity. As sapwood is even more valuable than heartwood, the trees can be marketed when comparatively young. Ten M board feet, or 20 cords, at 25 years are easily possible.

Hickory. (Hicoria laciniosa, [shellbark,] H. alba, [bullnut,] H. glabra, [pig nut.]) The first grows on moist land, the two latter on drier ground, but all require considerable fertility for a satisfactory development. The wood is highly valuable for vehicles and tool handles, and is preferred when young rather than when old. Where conditions are favorable, no crop is likely to be more valuable than one of hickory. It will usually be marketed in the form of billets and measured by the cord. A yield of 15 cords in 25 years may be expected.

Basswood. (Tilia americana.) A tree in many respects similar to tulip poplar, though rather less rapid in growth. It may be planted as an alternative or variant.

Locust (Robinia pseudacacia) is in demand everywhere for posts and railroad ties. The trees grow with marvelous rapidity for a few years on any but the poorest soils, but soon slack up. They are, moreover, almost invariably attacked by a boring insect. Plantations should be made with a view to harvesting the crop at about 15 years of age. Two thousand posts per acre is a fair yield.

Trees not recommended. A few trees entirely unfit for economic planting in New Jersey are so persistently boomed that their real qualities should be known.

Catalpa. Grows very rapidly on rich, moist soil and in a mild climate. In North Jersey its late growth is apt to be frozen; in South Jersey only the best soils are fit. Its wood is valuable only for posts and poles, being very durable, but weak.

Black Walnut. The wood is valuable only when cut from the heart of large, old trees. A tree 40 years old might be 12 inches in diameter yet contain only a 4-inch cylinder of brown wood. The sapwood of young black walnut is very wide, light in color and unmarketable.

Silver (White) Maple. The tree requires good soil, while its wood is weak, perishable and of little value. In fact, no maple is worth planting for lumber in New Jersey.

Eucalyptus. No species is adapted to conditions in this State. The quick growing kinds are as sensitive to frost as orange trees.

SPECIES RECOMMENDED FOR VARIOUS LOCATIONS.

Poor Soil

Dry sand with little humus. (Natural Pitch Pine land.)	Very stony ground with little soil of any kind.

Pitch Pine
Austrian Pine
Scotch Pine

Medium Soil

Sandy or gravelly loam, dry with little humus. (Natural Chestnut Oak land in South Jersey.)	Ground of any kind naturally fresh, but exhausted by cropping or by fire. (Stones need not be considered.)

White Pine
Red Pine
Shortleaf Pine
Austrian Pine
Scotch Pine
Pitch Pine

	Norway Spruce (Avoid South slopes) Douglas Fir European Larch Silver Fir Balsam

Tulip Poplar
Red Oak
Black Locust

	Cottonwood White Ash Hickory Basswood

Good Soil

Loam with some humus. (Good arable land.)	Rich ground with standing water at times.

Stones need not be considered.

Any tree on the list	Norway Spruce Balsam Cottonwood White Ash Shellbark Hickory Basswood

HOW TO ESTABLISH A FOREST.

As every item of cost in growing a forest must be carried as an investment at compound interest until the timber is mature, it is important to save every possible expense.

Sowing Seed. The lowest initial cost is found when seeds are sown on the ground, yet neither that method nor planting the seeds in prepared spots gives good results. Birds, mice, dry weather and many adverse influences make it advisable to start with sturdy young trees.

Best to Plant Small Trees. These may be grown in a home nursery or bought. Unless the quantity wanted is great, the latter is the better plan and as cheap in the long run. Evergreens, in particular, require much skill to grow successfully.

Preparing the Ground. Though trees undoubtedly grow better when planted in worked and fertilized soil, the practice is to omit everything of the kind on account of its cost. If the ground is very weedy or covered with brush, it may be mowed and burned over; that is all.

Size of trees. There is no economy in large trees; the only advantage they possess is that the plantation shows sooner. On the other hand, very small trees are handicapped by the weeds. A safe rule is to use plants about a foot high. Deciduous species may be larger, evergreens smaller. Of the latter those that have been transplanted are stronger and better rooted than seedlings and are to be preferred unless the cost is too great. See Fig. 2.

How to Order Trees. If the number needed is not over five thousand, buy trees of the size required for planting and have them delivered at the time they are to be set. If the quantity is large, it may pay to get small seedlings and cultivate them for a year or two in a nursery (see p. 21). The latter plan has the further advantages that it produces strong, sturdy trees, and insures their being on the ground exactly when they are wanted.

How to Handle Trees Before They Are Planted. When a tree is out of the ground its roots must **never become dry.** It is especially important to guard evergreens since the foliage is active at all times and the draft upon the root moisture therefore constant. Deciduous trees without leaves are less sensitive. In foliage they should never be moved. Nurserymen now make it a rule to leave a quantity of earth about the roots of all evergreens over 18 inches high and keep it in place by a piece of sacking (ball plants), but this is not necessary with smaller plants if the roots are kept moist. When the box or package arrives, open it at once and thoroughly wet the contents. If planting is to be delayed more than forty-eight hours, take out the plants and heel them in in a convenient place to stay until wanted.

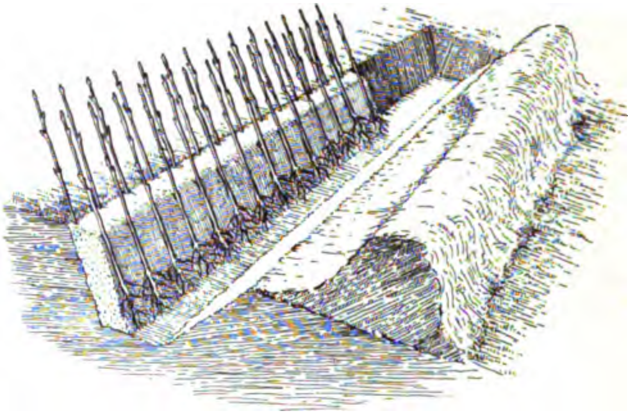


Fig. 4. Heeling in Young Trees. A trench properly made and two layers of deciduous trees in place; the first is covered in; the second ready to be covered. Evergreen trees should have none of the foliage covered.

Heeling In. This simply means putting a tree in the ground temporarily so that its roots shall not become dry before it can be regularly planted. With a number of trees to heel in, dig a trench in moist soil. Let the front of the trench be on a 45° slope and somewhat deeper than the length of the tree roots. Then loosen the tree bundles and spread the trees along the sloping wall in a single row and an inch or two apart. Cover the roots and lower stems with earth taken from the trench and tamp it down firmly so that every root is embedded. Successive layers of trees may be put one on another, with two or three inches of earth between, if the quantity is too great for a single row. If dry weather comes, wet the earth freely. Trees of any kind can be kept in this way several weeks without injury.

Spacing. The proper interval between planted trees depends upon the habit of the species, the strength of the soil, the expected life of the plantation, etc. In this part of the country it is most usual to space 6 ft. by 6 ft. in squares. Cottonwood should have a little more room, locust a little less. The aim is to give each tree room to develop a good-sized crown, yet not so much that it will have big lower branches, or the plantation need thinning before the stems are large enough to be salable. Straight rows equally spaced, thus,

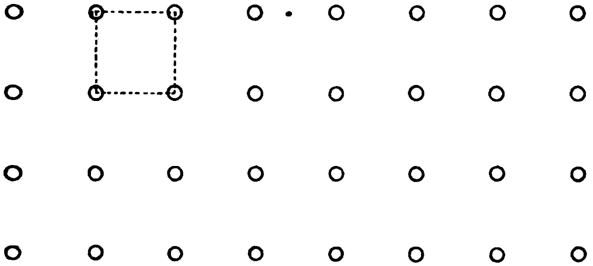


Fig. 5. Diagram Illustrating Tree Planting in Squares.

are better than "staggered" rows or triangular spacing, thus,

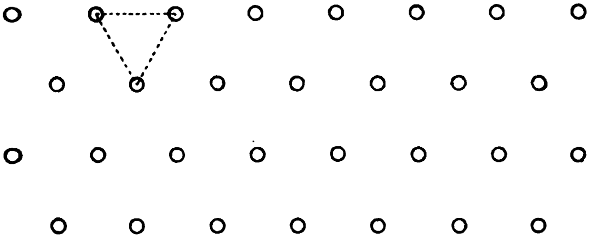


Fig. 6. Diagram Illustrating Tree Planting on Triangular Plan.

because removals can be made more uniformly when the time for thinning comes. Wider intervals between the rows than within the rows are justified only when one element in a mixed plantation is intended to be removed early.

TREES PER ACRE AT VARIOUS SPACINGS.

3 feet x 3 feet	4840 trees
4 " x 4 "	2722 "
5 " x 5 "	1742 "
6 " x 6 "	1210 "
8 " x 8 "	680 "
10 " x 10 "	435 "

Planting (Outplanting). It is well to work systematically though no more than a couple of thousand trees are to be set. As soon as the trees are brought on the ground mix a "puddle" and put the roots in it, leaving the tops in the air. "Puddle" is simply thin mud, preferably made of clay and water. It can be mixed in a tub or in a shallow pit. Provide baskets lined with wet moss or burlap, or pails, to carry the trees, and a heavy mattock or grub hoe for each planter—that is all. Baskets are lighter. If mattocks are not available, spades may be used, but not to dig holes; that costs too much, a cleft in the ground is enough. If the turf is close, or weeds very dense, "scalp" a square foot of ground where each tree is to stand.

Clefts. A satisfactory cleft is most easily made by driving a hoe or mattock, having a blade nine or ten inches long and five inches wide, deeply into the ground, raising the end of the handle and slightly twisting it to loosen the earth below, then lifting the loosened clod an inch or two as the mattock is withdrawn.

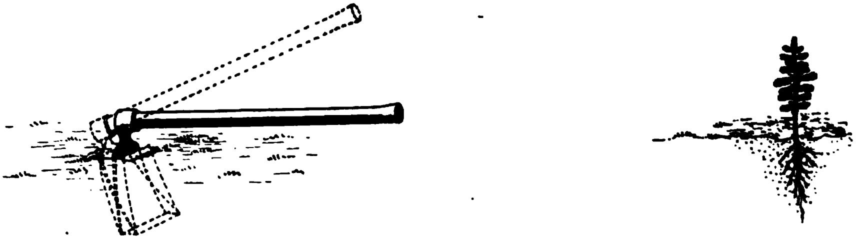


Fig. 7. Clert Planting. The mattock should be driven in as shown by solid lines, then raised, as shown by broken lines, before it is withdrawn. The tree at right shows how the roots are embedded when cleft is closed.

A spade driven straight down and then worked back and forth from the handle serves the same purpose, though less speedily.

Crew. Crews of two planters and one boy to hand trees to them, with a man to set the line stakes for several such crews and to puddle the trees, are most effective.

Lining-out. Let the line man set two stakes in each line, one at the edge of the plantation, the other 50 feet or more inside it. The planters then take their places at the opposite side of the plot and in line with the pairs of stakes.

Planting. Each planter sights over his two line stakes and drives his mattock into the ground at the proper point. After raising the handle, he slips one hand along to the head and with the other receives a tree from the basket boy. Then as the mattock is lifted with one hand the tree is put into the cleft with the other, the mattock is removed and the cleft closed with a stamp of the planter's heel. To spread the roots as much as possible, and not bunch them, it is well to put the tree deep into the cleft and before stamping withdraw it until the collar (the junction of stem and root) is about one inch below the ground surface. **Two things must be observed:** have each tree stand a little lower than it did in the nursery—never higher; be sure the earth is set close about the roots and that the tree stands fairly upright.

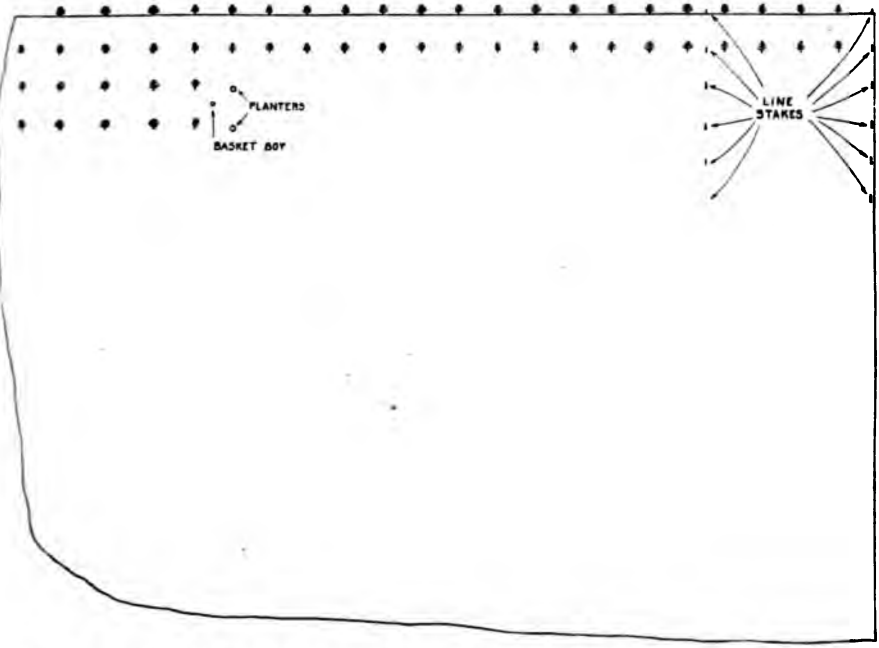


Fig. 8. Diagram of area to be planted. Two rows are finished, the planters are at work on two more. Line stakes have been set for six rows.

Intervals. After the first tree is set let the planter move forward the required distance and again sighting for his line, make his second cleft, and so on. It is always possible to approximate the required distance by pacing, by adding the length of the tool or of the tool and arm, to one, two or three steps. A six-foot interval can be fixed by taking one step forward and, with both feet set, making a mattock stroke at arm's length. It is not necessary to attain precision in line or interval; slight irregularities will be lost as the trees grow.

Speed in Planting. With the help of a line man and basket boy, two planters should set 200 trees per hour unless the ground is very stony or heavily turfed. One man doing all the work himself should average 600 trees a day. But do not acquire speed at the expense of good work. Watch the planters that they do not get carelsss and leave the trees bent or half embedded. Better not plant at all than invite failure through carelessness.

SUBSEQUENT CARE.

A forest plantation ordinarily needs no cultivation or special care. Fires must be kept out, of course, and stock also, but no expense for culture is warranted unless more than the economic production of lumber is involved.

Cutting Back. An exception to this rule is made when the growth of deciduous trees is slow. If each tree is cut off just above the ground the succeeding shoot is stronger and ultimately taller than the original would have been.

Replacement. If as many as 30 per cent. of the trees die the gaps should be filled within two years. If the loss is less, and is fairly well distributed, filling is ordinarily not done.

Cleaning. When a plantation is five or ten years old, sometimes earlier, it may be necessary to go through it and cut out brush, tree weeds and other undesirables. This should be done always, and only, when such growth interferes with the free development *upwards* of the planted trees. Keep the crowns of the young trees free to the sunlight; let low-growing brush and weeds alone. They stimulate height growth and shade the ground.

Thinning. No plantation made as here directed will need thinning before it is twenty years old. When the time for that comes further advice should be sought.

TIME TO PLANT.

In this climate early spring, as soon as the frost is out of the ground, is best. Be ready so that no time need be lost. Deciduous trees should never be taken from the ground while their leaves are on. Evergreens can be, and often are, planted successfully in late summer and early fall, but there is always danger that the winds of winter, often very dry, will put too great a strain upon the weakened root system of any tree that is moved in the fall. Cloudy or wet weather is always better than bright sunshine.

A FOREST NURSERY.

Small trees can now be bought at prices so low that it rarely is advisable to grow them from seed. But one can save much money, and have the trees when they are wanted, by establishing a transplant nursery.

Location, Soil. Choose a spot as for a garden; rich, warm, gently sloped and, if possible, with water for irrigation so that drouth shall not cause loss. In the spring, work the ground and fertilize it as for corn.

The Kind of Plants to Buy. Deciduous trees should be one year old rather than more. They are then from 4 to 16 inches tall. As evergreen trees of the same age are rarely over 5 inches tall, often not more than 2 inches, it usually pays to get two-year-olds.

Planting (Transplanting). When the young trees are received, care for them as directed on p. 16. When ready to plant, make furrows 18 inches apart with a hand-plow, going over each line twice if necessary to get the required depth. Or, if the soil is moist and compact, make a long cleft with a spade along each line. This method is often better than furrowing because the opening is deeper and the roots are more easily covered.

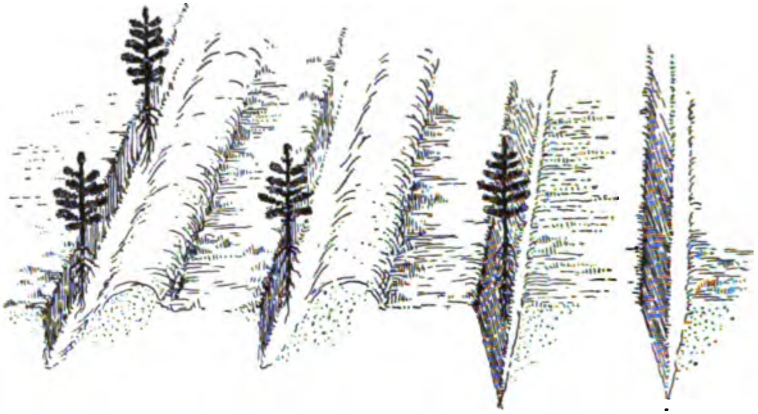


Fig. 9. Furrow Planting and Slit Planting. At left the earth is shown as opened by a plow with trees set against the vertical sides but not covered in. At right slits have been made with spades to receive the trees.

Let each planter then take a pail partly filled with trees whose roofs have been puddled as directed on p. 18. Beginning at one end of a row, he then sets the trees by hand about 6 inches apart. If furrows have been made, each tree is set against the vertical side and the earth scraped over and packed about its roots. If clefts, the tree is pushed down as far as it will go, then withdrawn until the collar is level with the ground surface and the cleft closed. As always, it is important to spread the roots as much as possible, not buch them, and to embed them firmly. See p. 19. After the planting is done, run a wheel hoe over the rows to close all gaps and level the ground.

Cultivation. Treat a tree nursery exactly like a garden. The planting method indicated implies the use of a wheel hoe. Keep the surface soil pulverized and destroy all weeds. Cease cultivating about August 20 so that growth may be checked and the shoots have a chance to lignify before frost comes. The weeds that grow after that time will help to shield the little trees over winter. If some of the trees are lifted by frost, as often happens when they are very small, they must be set back at once.

The Second Year. After the trees have been in the nursery a year one of three things is to be done. 1. Leave all to grow another season. In this case remove all weeds and trees that have died and continue the cultivation. This will be the rule where small evergreens are concerned. It is good practice if the

Scotch pine 7 years old, 5 feet high.

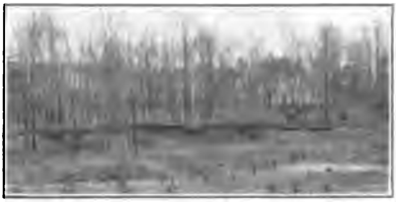
Locust 6 years old, 14 feet high.

White Ash and Red Oak 7 years old, 4 feet high.

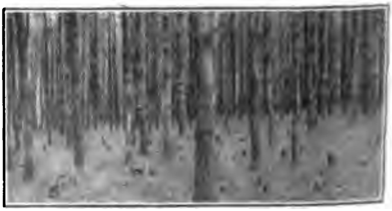
Beech 7 years old, 2 feet high.

Scotch pine 6 years old on a water shed.

Pitch pine 2 years old newly planted.



Jack pine filling a gap in a forest.



White pine 30 years old recently thinned.

FIG. 10. EXAMPLES OF PLANTED FORESTS.

land to be planted is weedy and strong plants are needed. Deciduous trees can often be induced to grow more vigorously by cutting off the main stem just above the ground. A sturdy sprout soon replaces the first growth. 2. Take everything for out-panting. This will be the rule with most deciduous trees as they should be large enough. Evergreens may have to stay. 3. Remove the well grown trees for out-planting and leave the smaller ones. This is always good practice if growth has not been uniform, as the weaklings then have a better chance.

Purpose of a Nursery. It is well to remember that the object of nursery treatment is to produce trees that are healthy and vigorous, that can be transplanted safely and that will give quick results in their permanent places. This is attained in commercial nurseries by constant care and thorough cultivation. Trees in a private nursery require no less.

THE COST OF A PLANTATION.

It is self-evident that a plantation can be made to cost more than it is worth—by using big trees, by spending more time than is necessary. It is quite as easy to do the work so hastily that there will be no permanent result. The necessary outlay includes only the cost of trees, delivery, labor in planting, and sometimes a charge for removing brush and putting the land in shape. Fair average costs may be estimated as follows:

COST OF PLANTED FOREST—PER ACRE.

Trees set 6 ft. x 6 ft.=1210 per acre.	Ordinary Conifers.		Deciduous Trees.
	4-year transplants 8″-12″ tall	3-year seedlings 5″-8″ tall	1-year seedlings 4″-8″ tall
	(at $10 per M.)	(at $4 per M.)	(at $3 per M.)
Trees	$12.10	$4.84	$3.63
Freight & hauling	1.00	.75	.75
Planting time at 20c per hr.	4.00	3.50	3.00
Total	$17.10	$9.09	$7.38

These costs can be materially reduced if the plants are bought small—2-year seedling conifers can be had for $3.00 per M and cultivated one or two years in a nursery. See p. 21. Some saving may also be made in planting cost, though too great speed always means poor work and ultimate loss. Of course, if home labor is employed, the entire planting cost may be ignored. On the other hand the cost may be considerably increased if many trees die and replacements become necessary. German forest plantations rarely cost less than $10 an acre even with the low wages that prevail.

WHERE TO GET MATERIAL FOR FOREST PLANTING.

The State of New Jersey Furnishes No Trees to Forest Planters.

Young trees can be obtained from many nurserymen, although as a rule those who handle ornamental stock do not have the large quantities of small trees that often are wanted, or are not prepared to make the price low enough.

Buyers are recommended to satisfy their needs from nurseries within the State, and, other things being equal, from that which is nearest the planting site, or which will deliver the stock so that it shall be the shortest time out of the ground. In all cases it is advisable to stipulate that stock shall be taken from the ground of the vendor—not assembled from other nurseries.

The following carry a good variety in moderate quantities:

Bound Brook Nurseries,	Bound Brook
The Elizabeth Nursery Co.,	Elizabeth
Hiram T. Jones,	Elizabeth
Joseph H. Black, Son & Co.,	Hightstown
North Jersey Nurseries,	Millburn
Arthur J. Collins,	Moorestown
Bobbink and Atkins,	Rutherford
Steele's Pomona Nurseries,	Palmyra
F. and F. Nurseries,	Springfield

As there are no nurseries in the State especially devoted to forestry stock, it is sometimes advantageous to buy large quantities outside—specifying always that the trees shall be grown by the seller in a nursery subject to State inspection, and under a guarantee that they are free from dangerous insects and disease. Prices should be based upon size, not upon age alone.

The following nurseries are well known and can meet the above conditions, except as to convenient location:

North-Eastern Forestry Co.,	New Haven, Conn.
D. Hill Nursery Co.,	Dundee, Ill.
Isaac Hicks and Son,	Westbury, L. I.
Biltmore Nurseries,	Biltmore, N. C.
American Forestry Co.,	South Framingham, Mass.

Buyers of planting material must make their own bargains and assume all responsibility. The Forest Commission furnishes the above information solely for the convenience and benefit of planters who do not know where to get what they need. It has no interest in, or preference for, any nursery or source of plant

THE PROFIT IN PLANTED FORESTS.

No planted forest can be a bonanza. Tree growth rarely averages more than six per cent. a year (wood volume), consequently the profit is determined by what the land will produce plus the increase in land and lumber values, minus the cost of care, taxes and compound interest on the investment. As land values and lumber values are steadily increasing, while planting costs are as low as they ever will be, almost any plantation made now on land of low value is practically sure to yield a fair profit. As forestry has no place on land that is valuable for something else, moderate returns are many times better than nothing at all. The following will show what may reasonably be expected, though it is emphasized that no one really knows what lumber will be worth forty or fifty years hence or what expense in the way of taxes, etc., may be involved. We can only make estimates, using the best knowledge that we have of rates of growth and the tendencies of lumber and land values, and of tax levies. The latter in particular are so uncertain that each owner must make his own estimate of the probable burden. For the sake of simplicity only initial costs and final yield are considered. In fact, there will be some intermediate costs and some income from thinnings. The latter, however, should more than balance the former. Immunity from fire and other dangers is assumed. Forestry is utterly impracticable where there are forest fires!

EXAMPLE 1.

EXPECTED PROFIT FROM A PLANTATION OF WHITE PINE OR AUSTRIAN PINE ON ROCKY GROUND IN NORTH JERSEY—PER ACRE.

INVESTMENT.

Land	$6.00	
Planting Cost	9.00	
	$15.00 with compound interest at 5 per cent. for 40 years....=	$105.60
Taxes—1 per cent. on land value=6 cents paid annually for 20 years; then 1 per cent. on $30 (average value land and forest)=30 cents for 20 years; all with compound interest at 5 per cent..........=		15.16
Protection=10 cents paid annually for 40 years with 5 per cent. compound interest ....=		12.08
	Total investment	$132.84

YIELD.

Sale Value after 40 years:	
20 M ft. lumber at $10 per M stumpage	$200.00
Land at original price	6.00
Total	$206.00
Less cost	132.84
Net profit	$73.16

Or, figured another way:

INVESTMENT.

Land	$6.00
Planting Cost	9.00
Capital at 5 per cent. required to produce cost of Taxes and Protection as above	5.00
Total	$20.00

YIELD.

Sale Value after 40 years:	
20 M ft. lumber at $10 per M stumpage	$200.00
Land at original price	6.00
Capital for expenses	5.00
Total	$211.00

This $211. equals 6 per cent. compound interest on the original investment of $20.

EXAMPLE 2.

EXPECTED PROFIT FROM A PLANTATION OF RED PINE ON SANDY SOIL IN SOUTH JERSEY—PER ACRE.

INVESTMENT.

Land	$5.00	
Planting Cost	8.00	
	$13.00 with compound interest at 5 per cent, for 60 years....=	$242.84
Taxes—1 per cent. on land value=5 cents paid annually for 20 years; then 1 per cent. on $20 (average value land and forest)=20 cents for 40 years; all with compound interest at 5 per cent..........=		35.80
Protection—10 cents paid annually for 60 years with compound interest at 5 per cent. ....=		35.36
	Total investment	$314.00

YIELD.

Sale value after 60 years:	
30 M ft. lumber at $12 per M stumpage	$360.00
Land at original price	5.00
Total	$365.00
Less cost	314.00
Net profit	$51.00

Or figured to show the rate of profit as in the first example:

INVESTMENT.

Land	$5.00
Planting Cost	8.00
Capital at 5 per cent. required to produce cost of Taxes and Protection as above	4.13
Total investment	$17.13

YIELD.

Sale Value after 60 years:	
30 M ft. lumber at $12 per M stumpage	$360.00
Land at original price	5.00
Capital at 5 per cent. required to produce cost of Taxes and Protection as above	4.13
Total	$369.13

This $369.13 equals 5.25 per cent. compound interest on the original investment of $17.13.

EXAMPLE 3.

EXPECTED PROFIT FROM A PLANTATION OF COTTONWOOD ON DISUSED BUT SUFFICIENTLY STRONG LAND IN NORTH OR SOUTH JERSEY —PER ACRE.

INVESTMENT.

Land	$10	
Planting Cost	10	
	$20 with compound interest at 5 per cent. for 30 years....=	$86.40
Taxes—1 per cent. on land value=10 cents paid annually for 10 years; then 1 per cent. on $25 (average value land and forest)=25 cents for 20 years; all with compound interest at 5 per cent. ....=		11.60
Protection—10 cents paid annually for 30 years with compound interest at 5 per cent. ....=		6.64
	Total investment	$104.64

YIELD.

Sale Value after 30 years:	
25 M ft. lumber at $10 per M stumpage..........................	$250.00
Land at original price	10.00
Total	$260.00
Less cost	104.64
Net profit	$155.36

This may be calculated, in the same way as the two former illustrations, as equivalent to 8 per cent. compound interest on the original investment.

STATE AID IN FORESTRY.

To encourage the practice of **forestry** on private lands, the Forest Commission offers the **services of its foresters,** so far as their time will permit, to all who ask for them. The assistance given includes the examination of woodlands and making recommendations for their management. Where cutting is necessary. a part of the trees to be felled will be marked to guide the owner in the removal of the rest. Advice in regard to markets will be given, but in **no case** will the forester have **part** or interest **in a sale.** Those who wish to undertake **forest planting** will be advised regarding the most suitable species for their situations, how to obtain the trees and how to plant them. The State supplies no planting material. Fire protective plans will also be formulated.

In all cases the **assistance** given **is advisory**. There is no obligation to follow the recommendations made, though where they are acted upon the Forest Commission claims the right to inspect the property from time to time and to publish facts concerning the work for the benefit of the public. The cost to the owner is the forester's actual expenses while away from Trenton. His salary is paid by the State. Public institutions, Shade Tree Commissions, etc., will be aided without charge. Inquiries by mail on any forest or shade tree matter will be carefully answered.

Write to the State Forester, Trenton, about anything relating to forests or shade trees—not fruit trees.

FOREST FIRES MUST NOT BE TOLERATED.

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FOREST NURSERY

AND REFORESTATION WORK

IN

MASSACHUSETTS

PROPERTY OF DIVISION OF
FORESTRY
COLLEGE OF AGRICULTURE
UNIVERSITY OF CALIFORNIA

By R. S. LANGDELL, ASSISTANT

UNDER THE DIRECTION OF F. W. RANE, STATE FORESTER

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INTRODUCTION.

State Forester has been anxious to place in the hands of ple some definite information on forest nursery and refor- work. It is believed that this bulletin will meet the nents.

y every farm in Massachusetts — in fact, in New Eng- has its woodlot, or some land suited only to the growing . In most cases such land has been wholly or partly cut ourned over, and left as barren, worthless tracts, an un- addition to the rest of the property.

the purpose of this bulletin to set forth a remedy which ng these waste and denuded lands back into forest growth, vide a method to keep them in a condition to be a source lue to the owner at a very small outlay. If, when a wood- it off, provision is made for restocking it, either by natural ction, as the leaving of seed trees, or by replanting it with -grown stock, much headway will be made towards bring- waste lands of Massachusetts back into forest growth.

ery work and that of reforestation go hand in hand though irely separate undertakings. It is from the nursery that ng trees are furnished to be used on land to be restocked.

ACKNOWLEDGMENTS.

work of writing and compiling the data in this bulletin rusted to Mr. R. S. Langdell, my assistant, who has for t six years been devoting his energies to carrying on the work at Amherst, and furthering the reforestation work hout the State. This bulletin was first issued in 1910, but lition becoming exhausted, we now offer the second edi- ith slight additions.

F. W. RANE,
State Forester.

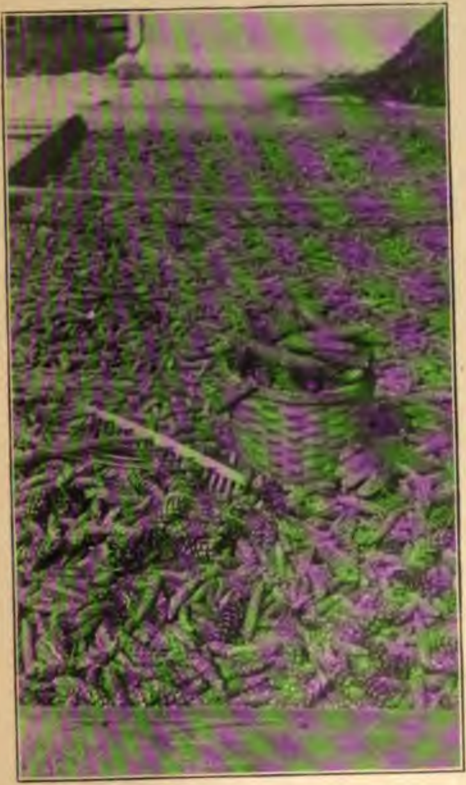

FIG. 1.—Pine cones spread out to dry, in order that seed may be extracted.

FORESTRY
COLLEGE OF AGRICULTURE
UNIVERSITY OF CALIFORNIA

EFORESTATION IN MASSACHUSETTS.

THE FOREST NURSERY.

of the first things in nursery work is the procuring of the n most cases our native trees furnish this in great abun- though in some years the seed crop is much more heavy others, due to climatic conditions. Practically all of the ferred to may be easily gathered in almost any locality out the State.

Procuring the Seed.

white pine (*Pinus strobus*), our native pine, bears its seed ones or burrs, which generally grow in clusters of twos or n the upper branches of the tree. Many persons wonder s that they cannot find the seed in the opened cones picked y pine grove; in fact, a number of cases have been known persons have planted the cones which have fallen to the in late fall or winter, the scales open and the seed escaped, pected to obtain a crop of trees. The seed is located two ach scale of the cone, and is about the size of a raisin seed, rovided with a small, bee-like wing, which favors its dis- n by the wind. The cones commence to turn brown in tion about the middle of August, and from then on ripen pidly, one or two sunny days drying the scales so that they d set the seeds at liberty. The cones must therefore be while green, before the scales have opened, by climbing the l picking by hand or with pruning shears. Sometimes a may be fortunate enough to find a large number where the e being cut for lumber, — they are then readily picked skets. The squirrels also at times cut off large numbers s, which fall to the ground and can be gathered up, care aken to select cones which have matured sufficiently for ls to be fertile.

the cones are picked they should be spread out in the sun nooth floor (Fig. 1), where they can be raked over from time, to aid drying. In a week or two the scales will begin to open and the seed fall out. The cones can then be raked off and the seed swept up. If the cones are then put into a bag and flayed, any remaining seed will rattle out. The cones should be kept from getting wet while drying, as the scales will close and will have to dry thoroughly again before opening. They should also be kept away from birds and mice, which often destroy large quantities of seed before being detected. If a large amount of seed is to be extracted, a drying room with drying racks and screens may be provided.[1]

Spruce, hemlock, larch, Norway pine, pitch pine and other coniferous tree seeds can be gathered and extracted in the above manner. If properly stored, the seed in most cases retains its vitality for a number of years.

The seed should be cleaned by winnowing, and then put into bags and kept in a cool, dry place through the winter, to be in readiness for planting the following spring.

The seed of maple, ash and other deciduous trees, except the nut trees, is most readily picked from the tree. The oak, chestnut, hickories, locust and some others ripen their seed in the fall, and shed it to the ground by the action of frost and wind.

Layering Seed in Sand.

It is best in most cases to protect the germinating qualities of nut seeds during the winter by storing in sand.

Layering is a method of storing certain seeds through the winter, and should be resorted to when keeping chestnut, oak, hickories, etc. For this purpose a well-drained slope should be selected, and a hole dug in the ground large enough to hold the seed; a layer of sand about 3 inches deep should then be placed in the bottom, then a layer of seed, followed by a layer of sand, and so on till the seed is stored. It should then be covered about 1 foot deep, to protect it from freezing and thawing. When only a small amount of seed is to be stored, a large drain pipe set in the ground with the bottom covered with fine mesh wire is very convenient, the seed being layered inside the pipe, to protect it from rodents. A wooden box used instead of the drain pipe will answer the purpose very well, and make it easier to remove the seed in the spring.

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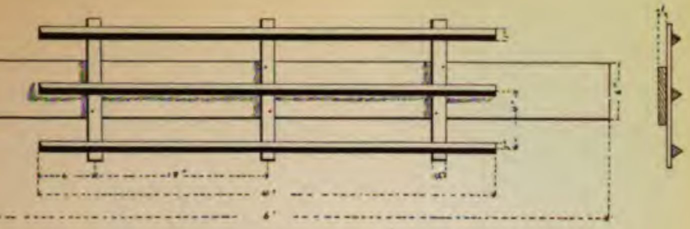
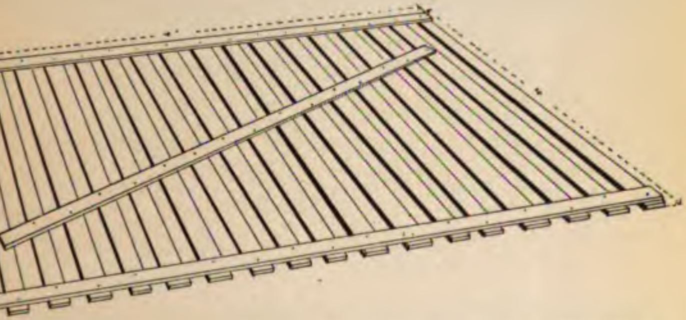
[1] Bulletin No. 73, Forest Service, Washington, D. C.



IG. 2.— View of marker for making drill in which to sow evergreen seeds.



. 3.— View of lath screen to be used in shading evergreen seedlings from the sun

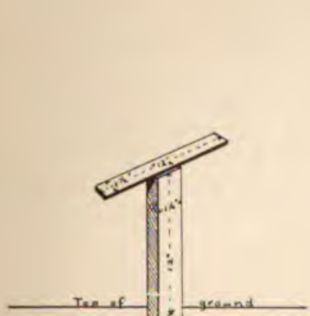


FIG. 4.—Stake to be driven into ground to hold screens above the seed beds.

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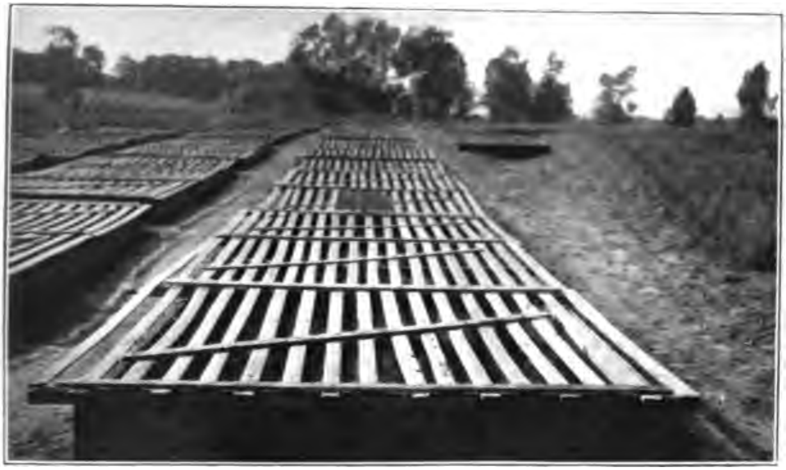


Fig. 5. — Showing method of screening evergreen seedlings from the sun (broadcast method).

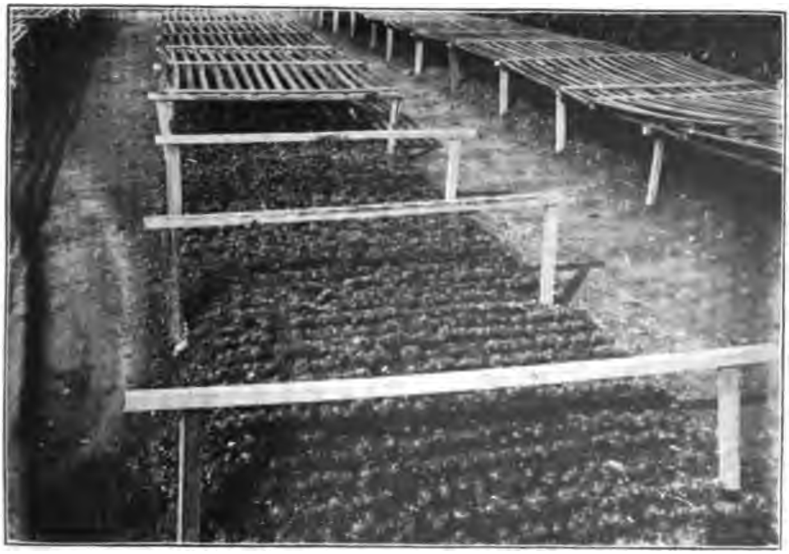


Fig. 6. — View of the seed beds with screens removed, to allow the beds to dry out and prevent damping off (drill method).

Site for a Nursery.

el, well-drained site should be selected for a nursery, the ng preferably a sandy loam, not subject to washing and m stones. It is also well to select a plot near the house, t will be convenient to take care of, and offer some pro- from birds and rodents, which often destroy the seed after been planted. A small plot in the garden will be well or the purpose.

Preparation for the Seed Beds.

and to be used for the seed beds should first be well plowed rowed till the soil is pulverized. A small amount of well- barn-yard manure, free from weed seeds, may be used to ige. The beds should then be laid out, the most con- size being a bed 4 feet wide and any convenient length, alks 2 feet wide between the beds. If the surface soil water it will be well to raise the bed a few inches above k, and have it about 1 inch higher in the center than on es. This will give the moisture a chance to drain off. he beds have been made up they should be raked over iron rake till all small stones and lumps have been re- and the soil thoroughly pulverized. The beds are then or the seed, which may be planted in drills or sown broad-

Time to plant Seed.

rule, the seed should be planted in the spring, as soon as und has warmed up a little, generally in April or May.

Drill Method (a Marker).

making the drills to plant pine seed, a marker made of f wood 4 feet long, mailed to cross-pieces on a board, with ips about 4 inches apart, and so arranged as to make a out ½ inch deep, has been found very useful. The marker can then be pressed down across the bed. If, each time oved, the inside cleat is allowed to rest in the trench pre- made by the outside cleat, very uniform drills can be

Drill Method (Sowing the Seed).

After the drills have been made, the seed should be sown similarly to any garden seed. In case of pine seed, if sown nearly touching each other, 1 pound would cover a bed 4 feet wide and 40 feet long. After the seed is sown, it should be covered by lightly brushing or sifting a little fine soil over it and firming it slightly. If the marker has been made by nailing strips to a smooth board, the back side can be used for this purpose.

Broadcast Method (Box Beds).

Most nurserymen prefer to sow seed broadcast, as it takes less space and there is much less weeding, the seedlings growing nearer together and checking or choking out the weeds. In order to keep the edge of the beds from washing, they are enclosed in a wooden frame made of 1-inch boards 6 inches wide. The frame is 12 feet long and 4 feet wide. The bed inside the frame should be raised slightly above the walks outside to assure drainage, and holes can be bored at intervals along the bottom of the frame to allow the water to run out. Some nurserymen recommend making a wire screen for the top and sides, to protect the beds from rodents and birds.

White pine seed may be sown broadcast about $\frac{3}{4}$ of a pound to a bed. The ground should be slightly firmed by light pressure on a board or tamper, and a little sand sprinkled over the bed to the depth of $\frac{1}{16}$ of an inch will be sufficient covering.

Mulching.

As soon as the seed is sown, the beds should be covered over with leaves or needles about 3 inches deep, or burlap the width of the bed may be used if the corners are slightly weighted to keep the burlap in place, in order to hold the moisture in the ground and keep an even temperature. This prevents the soil from becoming dry, in which case the seed would not germinate. As soon as the seed commences to appear above ground, the mulch should be carefully removed. Screens for shading should be provided in the meantime, as pine seed does not generally germinate for from two to three weeks.

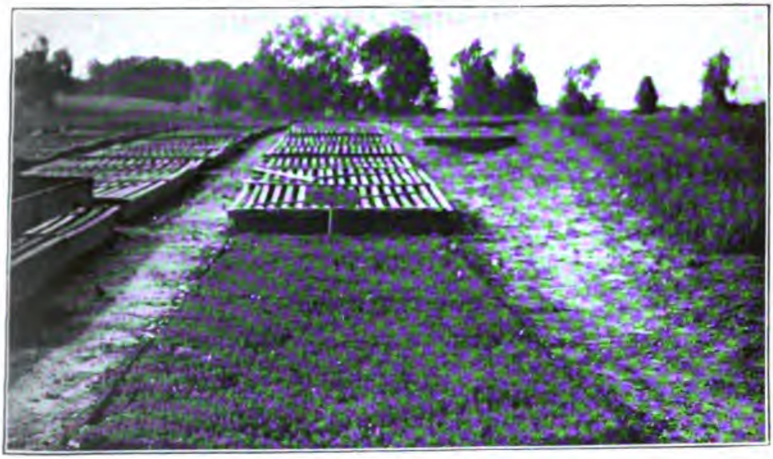


FIG. 7. — Two-year-old Norway spruces grown broadcast. Box-led frame removed the second year.

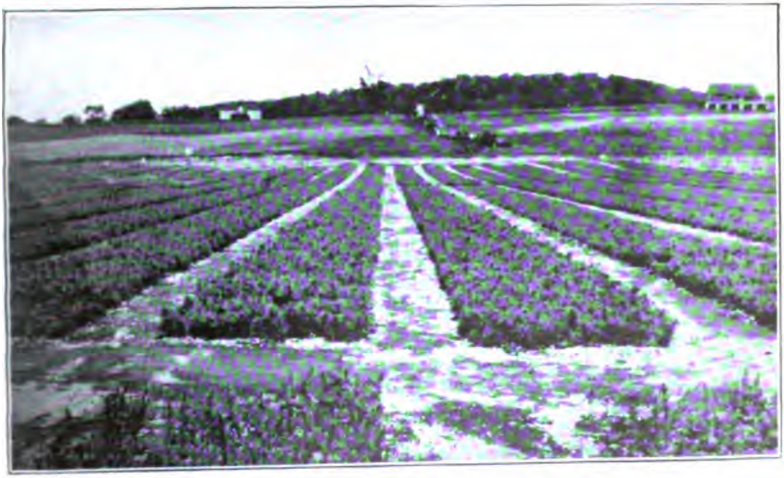


FIG. 8. — Transplant beds, State forest nursery at Amherst.

Shading.

the first two years most coniferous seedlings need to be ted from the sun (Figs. 5 and 6). For this purpose lath s (Fig. 3) may be cheaply made, using two laths as cross- and nailing others to them about their width apart. If a nailed on slanting through the middle, it makes the screen more firm. The screens should then be placed about 1 foot the bed, the laths running north and south. Stakes with s-piece 1 foot long nailed on top (Fig. 4), stuck into the l at each corner of the screens, will hold them in place. In ox beds are used the screens may be laid directly on the the frames.

Damping off.

r the seedlings have appeared above ground and the mulch removed, a dangerous disease to the seedlings is liable to r, especially if cool, wet weather sets in. This disease the seedlings to wilt or die off in large numbers, the stem he ground rotting off, so that the seedling tips over and The best way to prevent this disease is to remove the s for a short time each day. Care must, however, be taken allow them to remain off long enough for the sun to burn edlings, as they are very tender at this stage. If the beds rinkled with coarse sand, it also prevents the soil from be g wet and damp.

seed beds should be carefully weeded as soon as any weeds r, care being taken not to root up the seedlings. After the ngs have obtained a good start, the roots have branched out firm hold has been secured, a small hand weeder may be between the drills, to remove the small weeds and at the time cultivate and fine the soil about the roots of the trees. , chestnut and other deciduous tree seeds may be sown in 3 or 10 feet wide and 25, 50 or 100 feet long, the seed being d about 2 inches apart in trenches 1 foot apart. This ample space for cultivating seedlings. It is a safe rule to seed twice its own depth, as if planted too deep it is liable come up till the following spring. Under average condi deciduous seeds need not be mulched or shaded. In a time they should be of sufficient size so that a small hand ator may be used.

Protection in the Winter.

In order to protect the tender seedlings from alternate freezing and thawing during the winter, they should be mulched with leaves, pine needles or burlap. The screens should then be removed from the seed beds of evergreens, and the mulch spread over the beds to a depth of from 3 to 4 inches. The screens can then be laid down on the mulch, to hold it in place and prevent it from being scattered by the wind.

The seedlings of deciduous trees need not be mulched, but it is often well to hill them up slightly just before the ground freezes, by piling a little earth up around the stem with a hoe or cultivator. Mulching may, however, be resorted to where the winter is severe.

In the spring, as soon as the snow is off and the frost out of the ground, the mulch should be removed and the screens put up over the evergreen seedlings. Weeding should be done when necessary during the season, from three to four times probably being sufficient if they have been well taken care of in the previous year.

Hardening off of Evergreens.

In the later part of the season, when the sun is not as strong as during the summer, the screens should be removed for a short time each day, a little longer each time, and finally left off altogether. This will harden the plants, and get them into condition to withstand the second winter without mulching, so that they will be ready to transplant in the following spring.

Transplanting.

When the white pine seedlings are two years old, they should be either transplanted in the nursery (Figs. 7 and 8) or set in their permanent sites. It is generally preferable to transplant them in the nursery for one or two years, in order to form a more compact root growth and make a more stocky plant.

Two-year white pine seedlings can be set in beds 100 feet long and 4 feet wide, the rows running crossways of the bed, 6 inches apart. The trees are set 1½ inches apart, 31 trees to the row. A bed would contain 6,200 trees under this method of setting. The use of a transplanting board greatly facilitates the work.

intended to grow the trees more than one year in the t bed, they should be set in beds 100 feet long and 10 , the rows running lengthwise and 1 foot apart, the trees in the rows 6 inches apart. Under this method of growe or small hand cultivator can be used without injuring ; it also affords ample space for the growth of each tree. spring, as soon as the frost is well out of the ground May), the seedlings should be dug up and tied in bunches 100. In digging, care should be taken not to break off the small rootlets. It is also better to choose a cloudy he work, rather than a bright, sunshiny day, when there of the roots drying out quickly.

Puddling.

n as the trees are dug and tied into bunches, the roots e dipped into a puddle of mud and water mixed to the cy of common paint. This covers the roots with a thin f dirt, which prevents their coming in contact with the rying out.

Heeling in Young Trees.

p the trees in good condition till ready for transplanting, be temporarily set in a trench about 1 foot deep, dug side on a slant. The bunches of seedlings may then be le by side against the slanting trench, and a little damp wn over the roots and firmed down. Should it be into keep the trees heeled in more than a week, the bunches e untied and the trees separated and spread along the prevent them from heating.

ardwood trees should be transplanted when one year hey develop a long tap root, which, if allowed to grow nber of years without resetting, becomes so well rooted ll be impossible to dig up the plant without serious injury.

Root Pruning.

r to cause the tree to develop a compact root growth, it lly considered advisable to cut off a portion of the tap leciduous seedlings, such as ash, hickories, catalpa, etc. ing off of about one-third of the root causes it to develop growth.

Packing Seedlings.

When the trees are to be removed some distance from the nursery, the bunches should be packed in boxes, with the roots in damp sphagnum moss. A layer of damp moss should be put in the bottom of the box, and by alternating the bunches so that the roots will all be in the center, making first a layer of moss, then a layer of trees, and so on till the box is full, a large number may be packed in a small space. It is also well to puddle the roots before packing, giving them an additional coating of soil.

COMMON NAME.	Latin Name.	Seed.	of Seeds per Pound.	Time to collect.	Storage.	Time to plant.
White pine,	*Pinus strobus*,	$2 00	29,000	August to September,	Dry and cool,	Spring.
Pitch pine,	*Pinus rigida*,	3 50	20,000	October to September,	Dry and cool,	Spring.
Red pine,	*Pinus resinosa*,	6 00	75,000	September to October,	Dry and cool,	Spring.
Scotch pine,	*Pinus sylvestris*,	–	–	September to October,	Dry and cool,	Spring.
Norway spruce,	*Picea excelsa*,	75	80,000	September to October,	Dry and cool,	Spring.
European larch,	*Larix europæa*,	1 25	9,000	September to October,	Dry and cool,	Spring.
Arbor vitæ,	*Thuja occidentalis*,	2 50	70,000	September to October,	Dry and cool,	Spring.
Hemlock,	*Tsuga canadensis*,	5 00	65,000	September to October,	Dry and cool,	Spring.
Rock maple,	*Acer saccharum*,	1 00	7,000	September to October,	Layer in sand,	Spring.
White ash,	*Fraxinus americana*,	60	10,300	October,	Layer in sand,	Spring.
Tulip tree,	*Liriodendron tulipifera*,	75	9,000	October,	Layer in sand,	Spring.
White birch,	*Betula papyrifera*,	2 00	482,000	September to October,	– –	At once.
Beech,	*Fagus ferruginea*,	75	1,800	October to November,	Layer in sand,	Spring or fall.
Chestnut,	*Castanea Dentata*,	40	98	October to November,	Layer in sand,	Spring or fall.
White oak,	*Quercus alba*,	50	90	September to October,	Layer in sand,	Spring or fall.
Red oak,	*Quercus rubra*,	25	78	September to October,	Layer in sand,	Spring or fall.
Hickory,	*Hicoria ovata*,	35	80	September to October,	Layer in sand,	Spring or fall.
Black locust,	*Robinia pseudacacia*,	65	30,000	October,	Dry and cool,	Spring or fall.

Cost of Seedlings and Transplants per Thous

Variety.	Price of American	
	1 Year.	2 Years.
White pine,	–	$2 25–$4 00
Pitch pine,	–	2 25– 4 00
Red pine,	–	2 25– 4 00
Scotch pine,	–	2 25
Norway spruce,	–	2 25
European larch,	–	2 25
Arbor vitæ,	–	2 50
Hemlock,	–	24 00
Rock maple,	$6 00	15 00
White ash,	2 75	6 00
White birch,	–	20 00–30 00
Beech,	–	8 00
Chestnut,	8 00–15 00	–
White oak,	10 00–15 00	–
Red oak,	4 00–15 00	–
Hickory,	12 00–25 00	–
Black locust,	2 25– 5 00	–

REFORESTATION.

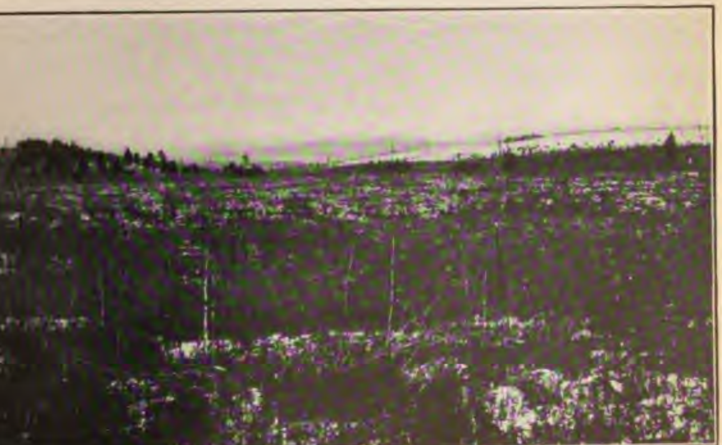
The total area of Massachusetts is about 5,321
which 2,672,950 acres is land adapted only to th
trees. Of this area there are about 700,000 acres
present time constitute practically worthless tracts
a tax to the owners, who at a very small outlay c
land back into a profitable forest growth, as well as
scenic beauty of the section.

This land lies in tracts varying in size from one t
acres. Practically every farm has a portion which
or another has been cut off, burnt over, or allowed
a condition where it is no longer a source of reven
of property which brings in no return, though it i
Lumbermen, mill owners, water-right companies a
have some land which falls under one of the follow
it is this sort of land which fortunately furnishes i
for forest planting.

9. —**Cut-over land, suitable for restocking with white pine. The sawdust pile tells the story.**

10. —**Burnt-over land,** where all the seed and young trees have been destroyed **by repeated** fires. Land should be reforested.

. 11. — Run-out pasture land, which should be brought back into forest growth.



. 12. — Land coming up to gray birch and undesirable hardwood, and which should be reforested.

Cut-over Land (Fig. 9).

n be safely said that every lumberman owns one or more of land which he has cut off, but which has not come back growth which will ever be of any great profit to himself rs, if allowed to remain in its present condition. Nature that this land should remain in forest growth, but through derate cutting it has come up to an undergrowth of small It is always preferable to restock this type of land as possible after it has been cut, as the sprout and hardwood s, if allowed to gain too great a headway, will hold the gs in check.

Burnt-over Land (Fig. 10).

and which has been subjected to repeated fires, destroying wth and ground cover, the soil is left free to the action of ather, to be quickly dried out by the sun, or, if on a side be washed into the valley by rains. The seed or seed-hich may have been on the ground have been destroyed, e land might lie for a long period of years before it would itself naturally. Land of this type, therefore, should be h considerable care, in order to obtain the best results. enerally advisable to set a three-year-old or four-year-old ant here, rather than seedlings.

Run-out Pasture Land (Figs. 11 and 12).

y of the farms throughout the State are becoming run out, e allowed to grow up to brush and undesirable hardwoods. e lands especially are being encroached upon by some of s valuable trees, such as bird cherry and gray birch, which rshade the ground that good pasturage runs out, and the bandoned for fields affording better forage. In many cases ing white pine have crept in, and probably in time would the whole piece; but the old trees, while doing good work eding, would be of little value, as, growing so scattered, ould develop large lateral branches, instead of giving a traight bole to the trunk, so desirable in the best grade of . If the lot could be set out with seedlings and the trees l to grow in sufficiently dense stands, the lower branches die off naturally, and smooth, clear lumber would be assured.

Seedlings and Transplants.

It is generally considered advisable to set tran
than seedlings, although under most conditions in t
two-year-old white pine has been planted with goo
a rule two-year-old seedlings may be planted on l
run-out pasture land or on cut-over land with good
being a little shade afforded by gray birch or low

Three-year-old or four-year-old transplants ar
planting on open land, exposed to the drying effe
wind (Fig. 13). As their root growth is large, the
deeply set in the ground where they can take up
whereas, if the roots were near the surface, as the
sarily be if seedlings were used, the trees would d
moisture in the top soil. It is also best to set tra
fields or mowings, where small plants would be be
choked out by the thick fog or dead grass.

Varieties to plant.

There are a number of varieties of trees which m
with good results. It is advisable to set some tr
naturally in the locality in which the work is to b

The white pine (*Pinus strobus*) (Fig. 14) has bee
for reforestation purposes throughout the State, an
itself to most of our New England conditions; in fa
of the country at one time was covered with prime
prised largely of white pine. The rapidity of its g
many uses to which the variety of wood may be p
practical tree for forest planting, and the one mos
work. It is, however, recommended to use some
on Cape Cod, unless the plantation is well prote
wind, which on the Cape causes a somewhat stunte

The white ash (*Fraxinus americana*) is well suite
on a springy side hill, where the growth and textu
of this variety often reaches its highest quality. I
tically immune from the attack of the gypsy a
moths, which are so detrimental to the trees in m
the eastern part of the State.

The Norway spruce (*Picea excelsa*), a tree grow

Land planted with white pine transplants, six years after setting.
Notice remarkable growth of leading shoot.

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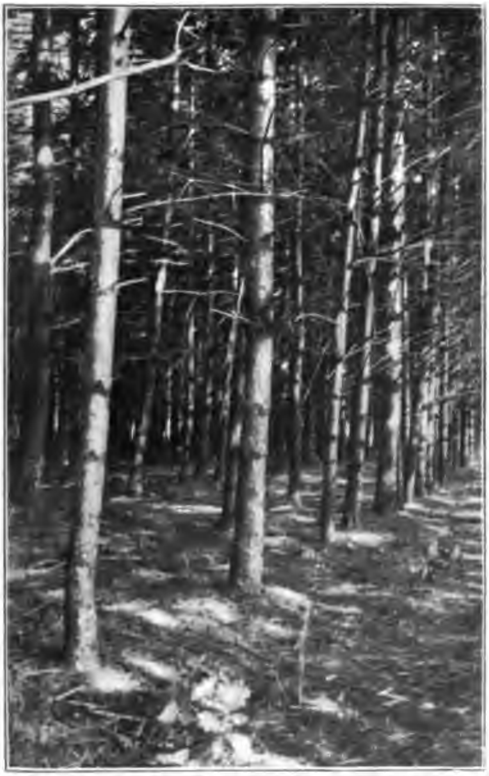

FIG. 14.—View of thirty-eight-year-old plantation of white pine, showing how the lower branches have died from lack of light, giving a clear, straight bole to the trunk, and producing clean lumber, free from large knots.

ale in European countries with climatic conditions similar own, is a tree well suited for planting in sections where our red spruce is the predominating species. It is a rapid , and its wood is also claimed to have properties for the ıcture of paper pulp not contained in other native trees. ariety has been planted quite extensively in New York where excellent results have been obtained.

planting on Cape Cod, the Scotch pine, pitch pine, Austrian lack locust and oak should be used. The Cape conditions ı a number of ways, and should be looked into to some before undertaking to plant the trees. In many sections Cape repeated fires have so destroyed the ground cover en burnt into the top soil that a transplant should be used, root could reach down into the soil deep enough to obtain re. In other cases a screen of some rapid-growing trees be planted around the plantation, to act as a protection he prevailing wind, which often causes the trees to lean. ost every instance a plantation on the Cape should have rotection from forest fires. The sandy formation of the ers great inducement for making and retaining a fire line, y small expense. A furrow in most cases could thus be vith a plow, and the dry, sandy soil thus turned up would a check to a running fire. It could be very easily kept free ar from dead grass, leaves and brush. In fact, if the towns sing the Cape could be brought to see the advantage of ining a strip 50 feet wide on each side of a town line, many large disastrous fires of that section could be prevented. s the town lines necessarily have to be blazed or marked few years, the labor and expense for such work could be way with. This is a line of work which might receive some on in other sections of the State, as well as on the Cape. umber of towns where a rather modified form of the work en done, it has been found remarkably effective and the e comparatively small.

Trees suitable for Forest Planting in Massachu

NAME OF SPECIES.	Soil.	
White pine, . .	Any soil not near coast or swampy,	Lumber, bo
Pitch pine, . . .	Sandy soil, on coast, . . .	Lumber, to
Red pine, . . .	Sandy soil, inland, ...	Lumber, shi
Norway spruce, . .	Sandy loam, ...	Lumber, Ch
European larch, . .	Light soil, ...	Piles, ship b
Arbor vitæ, . .	Sandy soil, ...	Posts, shing
Hemlock, . . .	Well-drained soil, or swampy, . .	Lumber, tie
Rock maple, . .	Well-drained soil, ...	Furniture, f
White ash, . . .	Wet land, swampy, ...	Lumber, car
Tulip tree, . . .	Sandy loam, ...	Lumber, pu
White birch, . .	Sandy or gravelly soil, . . .	Furniture, f
Poplar, . . .	Sandy or gravelly soil, . . .	Pulp wood,
Beech, . . .	Moist loam, ...	Tools, laths,
Chestnut, . . .	Well-drained soil, ...	Poles, posts,
White oak, . . .	Sandy loam, ...	Agricultural
Red oak, . . .	Well-drained soil, ...	Lumber, fue
Hickory, . . .	Sandy loam, ...	Carriage bui
Black locust, . .	Sandy soil, on coast, . . .	Posts, ties, e

Nurserymen.

Franklin Forestry Company, . . .	Watertown, M
Northeastern Forestry Company, . .	New Haven, C
American Forestry Company, . . .	South Framin
Massachusetts State Forester, . . .	Boston, Mass.
Keene Forestry Company, ...	Keene, N. H.

Spacing of Trees.

In order to produce a dense stand of trees, wh branches will die off and fall to the ground from giving a clear, straight bole (Fig. 14), so desirable fo poses, the trees should be set 6 feet apart each w 1,210 to the acre. The exact number will necess cording to the condition of the land. On rough, where the trees will be set only where there is suf the roots to obtain a firm footing, the number of t

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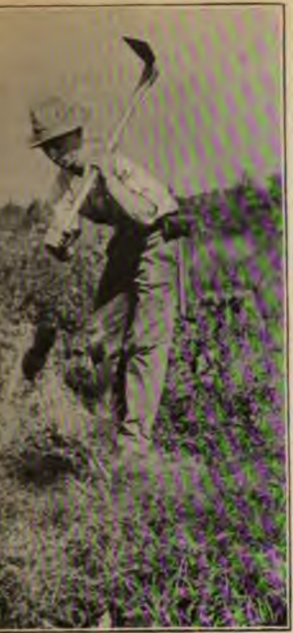
[1] The State Forester often knows of local growers who have from 1,00 sale each year, and is glad to give information in regard to them, but do his own nurseries.



5.—First step in making the hole.

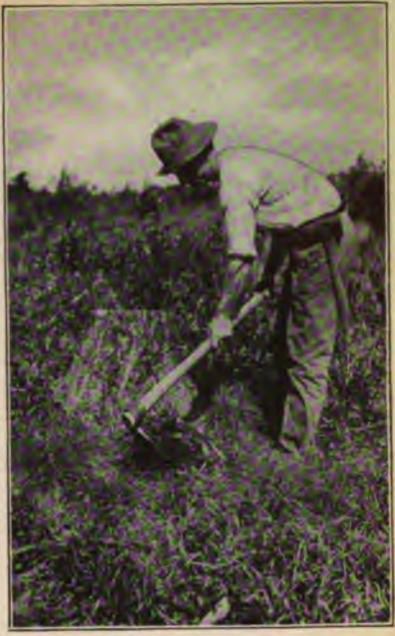
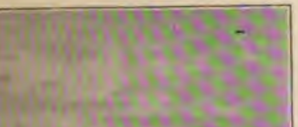


FIG. 16.—Second step in making the hole.



17.—Setting the seedling and covering the roots.

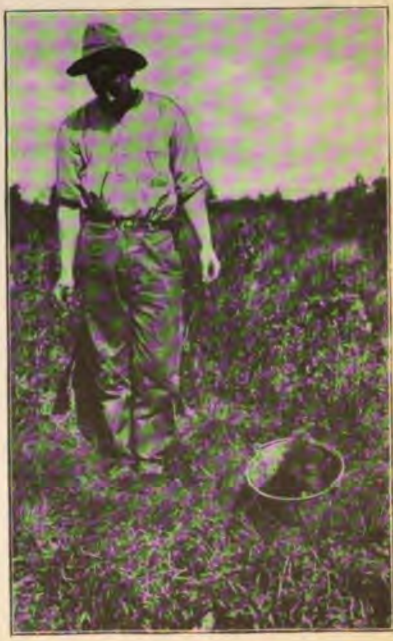


FIG. 18.—Firming the soil by pressure of the foot.

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w hundred less than on land covered by a good top soil. If the ees are set in rows running from one side of the lot to the other, will be found quite easy to keep track of the portion which s been set. The distance apart may be very readily determined making the holes two paces apart, or about 6 feet. It is also nerally considered best to make a clear planting, rather than to ix varieties.

Heeling in on Lot.

Where a large number of trees are to be planted, they should heeled in on the lot in a place where there is some protection om the sun; otherwise, a screen of brush may be put up. It ll also be well to choose a spot near a brook or stream, as the edlings will need to be watered if they become dry before trans-anting. After they have been set in their permanent site they ll take care of themselves, as to water them when spread out er a large area would be an almost impossible undertaking.

Method of setting the Trees.

The most convenient method of setting the trees is for the men work in pairs, one making the holes and the other planting the ees. The first man with a grub hoe or mattock should strike to the ground (Figs. 15 and 16) and make a small hole, leaving much as possible of the soil removed where it can be readily ed to place around the roots when the tree is set; then he takes o paces and makes another hole. The second man, carrying a il containing a bunch of seedlings, the roots of which are in a ddle of mud and water always to be kept in the pail, takes a ant and sets it in the hole (Fig. 17) at about the same depth as originally grew, covering the roots with fine soil and firming it wn by pressure of the foot (Fig. 18). The men should keep gether and work from one side of the lot to the other and then ck, the rows being kept about two paces apart. If stakes with gs are placed along the outside row and moved from time to me, it will be much easier to follow the row. One man should perintend from six to eight pairs of men.

Time to plant.

Planting should be undertaken as soon as the frost is ou ground in the spring, the month of April and first of Ma preferable, in order that the young roots may get started the dry season sets in. Spring planting is preferable to fal ing, as the roots having started will not be as likely to be out by the frost; although under certain conditions fall p is sometimes resorted to, as in a case where a piece of lan wet to work in the spring, but becomes dry during the s and fall.

Two men working in the above manner will set about per day, the expense of reforesting a tract, therefore, rangi $8 to $10 per acre, depending on the price of the trees us the cost of labor, white pine seedlings generally selling f $2.25 to $4 per 1,000, and labor ranging from $1.50 to day. The above estimate is based on about 80 lots pla the State Forestry department, the lots ranging in size fro 200 acres. It was generally found that the average cost i smaller on large lots than on small ones, the men becomi to the lay of the land, and thus being able to work with speed.

Protection of Plantation.

After the lot has been planted, it needs practically unless a large proportion die out, in which case the blanks be filled in with transplants. The lot should not be past many of the young trees would be trampled down. It well to put up posters prohibiting hunters and berry who often through carelessness start fires capable of great d

Fire Lines (Fig. 19).

Around large lots a fire line should be cut on the expos of the plantation, to protect them from forest fires creeping i adjoining land. A strip 50 feet wide cleaned of brush ha found very effective, the brush being piled and burned wh snow is on the ground (Fig. 20). On the side nearest the tion (Fig. 20) a trench 6 feet wide should be grubbed up or up, and kept free from weeds and dead leaves. In this fire working in from other land would be unable to jump

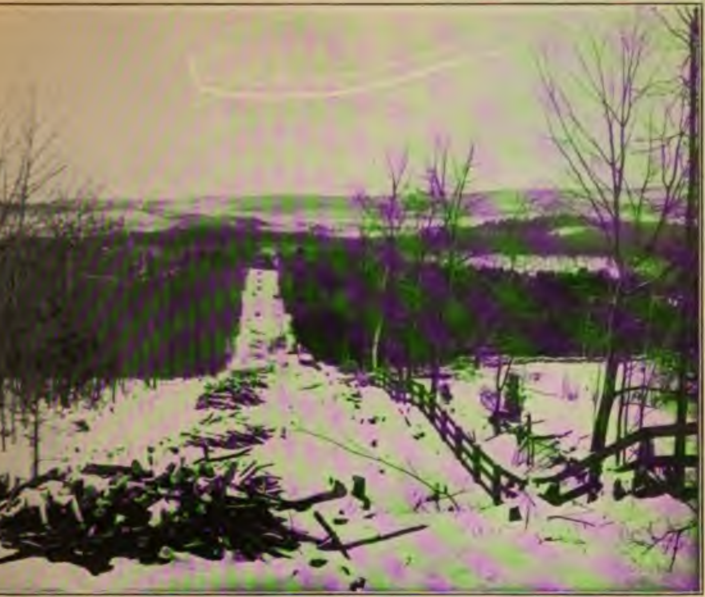
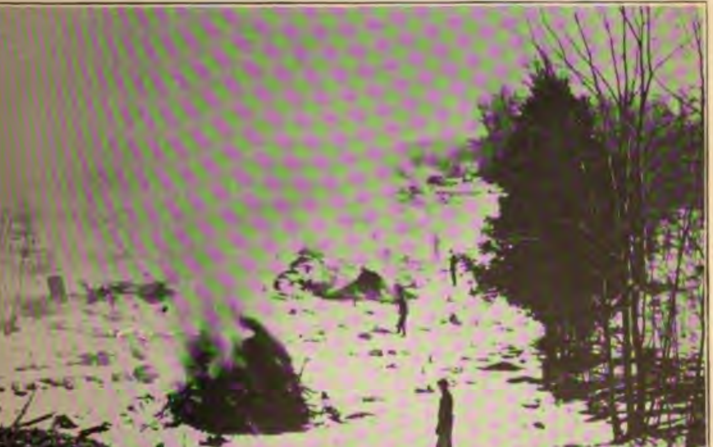


FIG. 19. — Fire line, Metropolitan Water Board reservation, Boylston.



G. 20. — Burning brush along a fire line, work being done when the snow is on the ground, to prevent the fire from running. A trench six feet wide indistinctly shown on the left.

ench, having nothing to feed on. A trench on the outside line would also be of advantage; but in case only one is deemed advisable, it is better to have it on the inside fire line. A line so made will offer a place for checking a back-firing. The cost will vary according to the growth has to be cleared. In cases where the wood is large enough it into cord wood, the expense will be small, the work paying for itself; but under average conditions, where no can be derived, the cost will vary from $150 to $200 per It is best to cut and pile the brush for such a line in early hen there will be no danger from sparks or fire running. A f this kind is of especial advantage along railroads.

xtremely dry times, when there is danger from berry pick- hunters, a look-out from some high knoll will be of advan- A fire patrol of a lot, whether planted, or a natural stand, tical in dry times. The old saying, that "An ounce of pre- n is worth a pound of cure," certainly applies in cases where fires are concerned.

REFORESTATION WORK DONE BY THE STATE.

er "An Act to provide for the purchase of forest land and orestation," passed by the Legislature of 1908, provision is that private land owners may turn tracts of land suitable orestation purposes over to the State, to be planted and d under practical forestry management, such owners reserv- right to redeem the land at any time within ten years, for tual amount expended.

ng the years 1909, 1910, 1911 and 1912 about 1,000 acres ar were planted under the supervision of expert foresters he State Forester's office, the work being done by local gangs 21) picked up in the various towns where the lots were d. The cost of planting, including price of trees and labor ing, ranged from $8 to $10 per acre, according to land and conditions. The first three years a large number of trees urchased from outside nurserymen, but in 1912 the out- the State nursery had increased sufficiently to meet the d, and by raising our own trees the cost is kept at a um.

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Reforestation Act.

SECTION 1. For the purpose of experiment and illustra management and for the purposes specified in section seve the sum of five thousand dollars may be expended in the hundred and eight, and the sum of ten thousand dollars a after, by the state forester, with the advice and consent of and council, in purchasing lands situated within the comm adapted to forest production. The price of such land shall any instance five dollars per acre, nor shall more than ei acquired in any one tract in any one year, except that a gre so be acquired if the land purchased directly affects a sourc of water supply in any city or town of the commonwealt acquired under the provisions of this act shall be conveyed to wealth, and no lands shall be paid for nor shall any money in improvements thereon until all instruments of convey title to be transferred thereby have been approved by the att and until such instruments have been executed and recorde

SECTION 2. The owners of land purchased under this heirs and assigns, may repurchase the land from the com any time within ten years after the purchase by the commo paying the price originally paid by the commonwealth, tog amount expended in improvements and maintenance, with rate of four per cent per annum on the purchase price. The with the approval of the governor and council, may execu the commonwealth such deeds of reconveyance as may be ne this section: *provided, however*, that there shall be included a restriction requiring that trees cut from such property less than eight inches in diameter at the butt.

SECTION 3. The state forester may in his discretion, b the approval of the deed and title by the attorney-general section one, accept on behalf of the commonwealth gifts of l and managed for the purpose hereinbefore expressed. A land may reserve the right to buy back the land in accord provisions of section two, but in the absence of a provision in his deed of gift he shall not have such right.

SECTION 4. Land acquired under the provisions of thi under the control and management of the state forester, w ject to the approval of the governor and council, cut and s and other produce therefrom.

SECTION 5. All moneys received by or payable to the c or any one acting on its behalf under the provisions of thi paid into the treasury of the commonwealth.

SECTION 6. Land acquired under the provisions of this sequently reconveyed under the provisions of sections two not be exempt from taxation on account of any plantatio out or planted while it was held by the commonwealth.

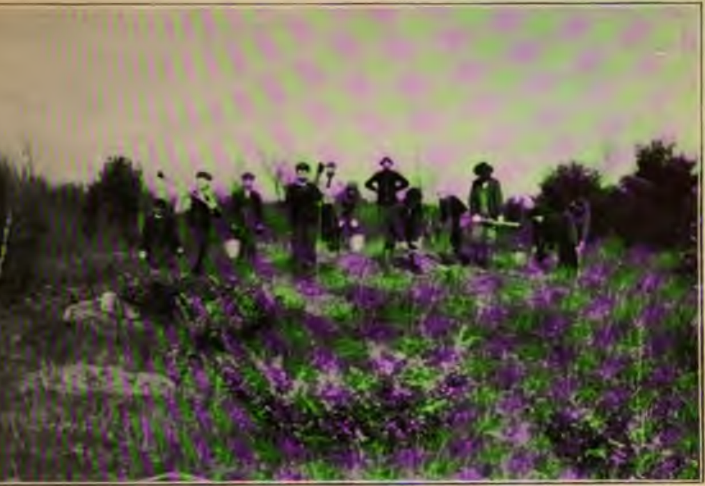
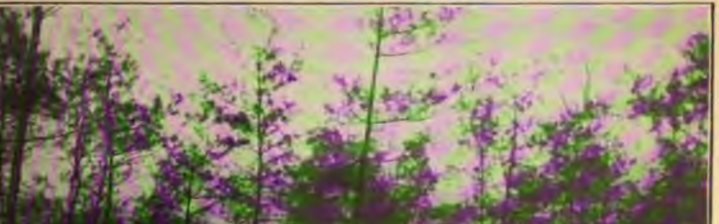


FIG. 21. — A planting gang at work under the reforestation act.



. 22. — View of example in thinning, where undesirable hardwoods have been removed and put into cord wood, to give the undergrowing stand of white pine a chance to grow.

ION 7. For the purpose of assisting in reforestation a portion, not ng twenty per cent of the money authorized by this act to be ex- may be used by the state forester for the distribution at not less st of seeds and seedlings to land owners who are citizens of the nwealth, under such conditions and restrictions as the state for- ıbject to the approval of the governor and council, may deem ad-

ON 8. The state forester shall replant or otherwise manage all quired by the commonwealth and held by it under the provisions act, in such manner as will, in his judgment, produce the best rowth both as to practical forestry results and protection of water .

ON 9. All acts and parts of acts inconsistent herewith are hereby l.

ON 10. This act shall take effect upon its passage.

purpose of the above act is to place before the people an e along forestry lines which will aid them in carrying out rk for themselves. For this reason it is desired that the as far as possible, take over lots easily accessible to main ys.

me instances lots have been taken over where it has been l advisable to protect the plantations from forest fires by a fire line, or making provision for some one in the near to be supplied with fire extinguishers and equipment for fires, and to patrol the lot in exceedingly dry times.

mber of lots have also been acquired where a small por- ıd some small growth which, if systematically thinned, e profitably handled (Fig. 22).

ite parties owning land in the State adapted for reforesta- rposes should make application to the State Forester, who dly furnish advice along forestry lines.

SYLVICULTURAL CHARACTERISTICS OF TREES.

ıost commonly found growing in Massachusetts, the Uses to ch their Timber is put, and a Few of their Most Important mies.

convenience in the matter of reference, we shall separate erent species under three heads: (1) conifers, (2) northern ods and (3) southern hardwoods, the term "hardwoods" sed for all trees other than conifers.

r (1) will be treated white pine, red or Norway pine, pitch cotch pine, hemlock, red spruce, and Norway spruce.

Under (2) come rock maple, beech, white birch an

Under (3), chestnut, red oak, white oak, red m hickory, black locust and white ash.

1. CONIFERS.

White Pine (*Pinus strobus*).

This species is placed first, both because of its ability to growth in this State and because of the un for its lumber.

It may be found growing in all sorts of situat extremely wet soil, such as swamps. This does mean that the tree grows equally well everywhe doubtedly prefers a well-drained, loamy sand, and its best development. Ideal conditions exist on th the bottoms of the old glacial deposits so numero State.

The white pine grows either pure or in mixtu species, but in the latter case the other trees shoul or under story about the pine, otherwise, the tree well, being too much shaded by the others. It is believe that white pine is a shade-enduring tree, f shade is beneficial in the early stages of growth, it ful at later periods.

Reproduction is by seed, which is produced an much larger quantities at intervals of from five to s "seed years." The seeding process is described where in this bulletin.

As regards size and rate of growth, white pine c ably with any eastern tree and far exceeds most of respects, reaching merchantable size in about fifty y in the "Forest Mensuration of the White Pine in M published by the State Forester in 1908. If left t turbed, it reaches a size excelled only by trees of th specimens having been recorded that exceeded 200 with a diameter of 6 feet, while heights of 100 fe diameters, are not uncommon.

The chief enemy of this tree, as of all others in fire, which, if it does not kill, so weakens it as to to attack by all kinds of insects and fungi. The cially susceptible when young, even a slight ground fire being e sufficient to completely kill it. In this respect it resembles chestnut.

eading insect enemies are the pine weevil and the various bark rs, all of which are much less likely to cause trouble in healthy ds than in those weakened by other causes. The gypsy moth, e it will eat pines as well as everything else, is not apt to de pure stands containing this species alone. The brown-tail leopard moths do not eat pine.

seems almost unnecessary to enumerate the uses of the tree, hey are so well known. Among them may be mentioned ling timber of all kinds, laths, various kinds of cabinet ma- l, interior finish, wooden ware, matches, flag poles, masts and s.

Red or Norway Pine (*Pinus resinosa*).

his tree, while common in southern Maine, is not so familiar sidents of Massachusetts, partly because it does not grow in stands, but only as scattered individuals, and partly because difficulty of collecting the seed renders the cost of planting r seed or seedlings very high. The tree, however, is a very lent species, and compares favorably with white pine in y respects.

grows on the same kind of soil as the white pine, but will on dry ridges, where the white pine will not. It will not in swamps or in poorly drained soil.

associates usually with white pine, growing in scattered ps throughout the stand. More rarely it is found in com- with hardwoods, such as oaks and birches.

ed pine is a rather poor seeder, not beginning to bear until t twenty-five years old, and then giving only light crops at or five year intervals. The seed will not germinate in thick or sod, and the seedlings require much light. A bare mineral containing some moisture is best. The percentage of germ- on is high.

rate of growth red pine is more rapid than white, especially young, though it is more short-lived in the long run. It nes a diameter of 23 inches and a height of 80 to 90 feet in hundred and twenty-five years, producing merchantable tim- Sixty years will produce good small stock.

No serious insect pests or fungous diseases atta
and it is remarkably free from rot. Light grou
injure it so much as they do white pine, especia
grows older.

The wood is used for general construction,
shipbuilding, car construction and flooring.

Pitch Pine (*Pinus rigida*).

This tree grows on dry sandy soils, and is espe
planting in such localities. When pure it forms ve
owing to its extreme intolerance, and it must be
species in mixture, or it will die.

It is a prolific seeder, and succeeds well under
ditions, and is also a fairly rapid grower, reach
height of 80 feet and a diameter of 30 inches.

It is not subject to attack by insects or fungi,
the most resistant to fire of any conifer in Mass
viving repeated burnings.

The wood is used largely for fuel, being brittle

Scotch Pine (*Pinus sylvestris*).

This tree is the common pine of northern Eur
there the same place that the white pine does in
a timber tree. Its growth, however, more closely
Norway, both in quality of lumber and in the ki
ferred by the tree.

It differs, however, in the fact that it grows well
stands rather than in mixture with other species,
it seeds often and abundantly, and therefore cost
grow than red pine.

In common with the other pines, Scotch is not
to disease and insect attack, but is somewhat mo
fire than red.

It is used for the same purposes as red pine.

Hemlock (*Tsuga americana*).

This tree, easily the most tolerant of the Ame
prefers cold north and east slopes of the hillsides i
parts of the State. Because of its extreme toleran

:h any other species, evergreen or hardwood, or in dense ds in all stages of growth.

eds are borne in very small cones, and are very light. tion is good under favorable conditions of soil and loca- the tree frequently grows apparently out of bare rock, the soil.

f this species often grow to a very large size, but such ls are apt to be rotten and shaky. Other species will under hemlock because of the dense shade cast by it.

od is being used more and more for building timber, as y of other species grows scarcer, and some lumber dealers to spruce for rough frame timbers. If care is not used it is very likely to check.

Red Spruce (*Picea rubra*).

ee is the timber spruce of Maine, and is now the most t species in that State in size of cut. It will grow in Massachusetts on the higher elevations, preferably in vith pine and hemlock.

grow in the shade of other trees for many years, and rked ability to start up and grow when suddenly exposed ht.

is not rapid, and large size is not reached by this species; , straight timber is produced, which finds a ready mar- e limbs do not drop off readily, however, and clear tim- herefore be grown only in dense stands.

e reproduces itself well when the leaf litter on the ground o thick, and the seedlings therefore start readily under re trees of the same species, forming a stand containing ll ages.

rincipal enemy is the spruce bark beetle (*Dendroctonus a*).

ses of the wood are well known; building timber, piano boards, inside finish, clapboards, and in Maine pulp- e among them.

Norway Spruce (*Picea excelsa*).

This is one of the principal timber trees of E strongly recommended for planting in this countr as it does, all the advantages of the red with the being a much more rapid grower.

2. NORTHERN HARDWOODS.

Rock Maple (*Acer saccharum*).

This tree, known also as the sugar maple, is on important of our northern hardwoods, both for s ber. It grows usually in mixture with beech, oak as well as conifers, but may grow in pure stands.

Its chief sylvicultural feature is its extreme tole it the most shade-bearing of all American hardwo possible exception of beech. A deep, moist soil is good growth.

Seed is produced almost every year, but full see only at intervals of from three to five years. The germination is rather low, but this is offset by the young trees to stand dense shade.

Growth is slow, but persists for a long time, the t height of 70 or 80 feet and a diameter of 2 or 3 fe is not very wind-firm.

Rock maple is not very susceptible to injury by though a good deal of damage is sometimes done tent caterpillar, which strips the foliage from the reduces its vigor. Another enemy is the "saddle (*Heterocampa guttivitta*), which has caused a great d in Maine and New Hampshire, but is now being b control by natural enemies.

Beech (*Fagus ferruginea*).

This tree is conceded to be the most tolerant of wood species found in Massachusetts; that is, it beneath the most dense shade, provided the soil i germination, and not only this, but it requires shad start at all. It grows best on rich, loamy soil, o ixtures with other hardwoods, such as the oaks, chestnut maple. It sometimes forms pure stands with here and there ering pine and hemlock.

e nuts are so much liked by squirrels that reproduction is ered by these animals.

e beech is a rather slow-growing tree, generally owing to dense shade which surrounds it; but it reaches good size, in height and diameter.

e principal enemy in Massachusetts may be said to be the dled prominent," previously mentioned, which prefers the s of this tree to all others, thus causing the woods to resemble er in the height of the growing season.

e wood forms one of our most valuable hardwoods, and is for tool handles, furniture, flooring and in turnery.

White Birch (*Betula papyrifera*).

is tree is to be rigidly distinguished from the gray birch etimes called "white") so common in this State. The latter es (*Betula populifolia*) is practically valueless for all pur- , fuel included, and must not be confused with the white, forms a valuable timber tree.

ite birch grows on northerly slopes, in mixture with other voods, pine and hemlock. The seed is very light, favoring duction by the wind, and causing the propagation of the es over burned areas when there is enough soil moisture to rt tree growth. The tree will not stand shade, being very erant, and the seed will not germinate on a thick layer of s, so that reproduction within the woods is unlikely.

ong, clear bole is developed by growth in the forest, the tree ing a height of 70 to 80 feet in sixty to seventy-five years. short-lived tree, seldom living over one hundred and twenty when grown from seed; sprouts do not live over ninety .

most serious enemy is fire, since it is not subject to attacks sects, fungi or windfall.

e wood is used, to the practical exclusion of all others, in manufacture of spools, shoe pegs, shoe shanks, and very y for toothpicks, dowels, bobbins, shuttles and various toys ovelties.

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Yellow Birch (*Betula lutea*).

This tree is quite commonly found in Massach
ture with evergreens and deciduous species, wher
guished by its yellow, shiny bark, usually of a tattere

It is a valuable species for ship building, furnit
hubs, having a very fine, clear texture of grain.

It is mentioned in this list not because we desire
ing this species, but in order that owners may rec
valuable tree, and not of the same class as the gray
of no value in itself, usually causes more or less
neighbors by interfering with their proper developn

3. SOUTHERN HARDWOODS.

Chestnut (*Castanea dentata*).

This tree, like the oak, reaches its best conditio
slopes of hills, or in coves where the soil is rich, m
deep. It will grow, however, on a very thin soil, i
It grows much more rapidly than the oaks, attainin
in about fifty years. Under favorable conditions i
height of 100 feet and a diameter of 3 or 4 feet.
growth is remarkable, excelling that of any decidu
poplar.

It bears a crop of seed each year, but the crop varies

The tree is quite intolerant, but, as it grows mor
the other hardwoods with which it associates, it ha
in getting all the light it wants.

The chestnut, in common with the hardwoods
eaten by the gypsy moth, but it has few insect en
to itself. It is, however, gravely affected by a fun
chestnut bark disease (*Diaporthe parasitica*), whi
practically every chestnut tree within twenty miles
The tree is severely injured by fire, on account o
and inflammability of its bark.

The wood is light, stiff, strong, and very dura
with the soil. It is used for ties, poles, building
slack cooperage and furniture. The wood is disti
duces a tanning extract used in the place of tan b
of chestnut has increased nearly 100 per cent. in th

The Oaks, White, Red and Black.

their best development our native oaks require a rich, oil, situated in cover or on the lower slopes of a hill. With eption of the swamp white oak, they will not grow on d; and, on the other hand, they make a fair growth on of dry, exposed ridges.

require considerable sunlight for their best development, black and red oaks will stand some shading. The white uite intolerant.

white oak bears seed nearly every year, but the trees of ck oak family require two years to mature the acorns.

oak is a slow-growing tree, requiring at best seventy-five o obtain a tree of saw log size. The black and red oak ore rapidly than the white in early youth, but the white intains its growth for a longer period, so that at the age rity there will be little to choose between them as to size.

n-tail and gypsy moths seem to be particularly fond of ut, as they eat other species very readily, this preference of great importance. The "saddled prominent" (*Hetero- guttivitta*), an insect now doing a large amount of damage nern New England, is known to eat it at times. The oak ually free from borers and bark beetles, and is quite re- to damage by ground fires.

wood is heavy, hard, tough, close-grained and very dur- White oak has these qualities to a greater degree than the l black. The wood is used extensively in ship building, ooperage, vehicle manufacture, farm implements, ties, in- inish and furniture. So great is the economic value of od that the available supply is being rapidly exhausted.

Red Maple (Acer rubrum).

tree is partial to wet land, and is our typical swamp tree, pure or in company with ash, hornbeam and hemlock. her swamp-land trees, it is very tolerant of shade, although condition its growth is slow.

ars an abundance of seed each spring.

r forest conditions it seldom attains a height of more than and a diameter of more than 15 inches. It grows quite

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rapidly when young, but slacks materially whe years old.

It is not attacked so readily by gypsy and brow are most of the other hardwoods.

The wood is lighter, not as strong and more s than is hard maple, but is sometimes used as a s

It is not a tree that is recommended for forest

Shagbark Hickory (*Hicoria ovata*).

This tree is of increasing importance because scarcity, due to the heavy demand for hickory woo caused by its unrivalled good qualities for certai struction.

It is primarily a tree of fresh, fertile soils and along streams, and produces good wood in clay so

It is never found pure to any great extent, but ture with other species, and, being very tolerant, in the shade of the others.

Seed is borne in a fairly prolific manner ever years, but the nuts are largely eaten by weevil Growth is not very rapid, but is extremely pers living to an age of two hundred to two hundred years, in full vigor. Timber trees are produce hundred years.

The wood is used for vehicle construction, hand It is the strongest of the hickories except pignut, favored over that species except on dry soils and no market for the nuts.

Black Locust (*Robina pseudacacia*).

The black locust is a more southern species, b Massachusetts, and is recommended where a qui is desired. It demands plenty of light and a m produces its best wood at forty to fifty years, rea 60 to 70 feet in height. The seed is borne in pod them preserves its germinating power for severa lings grow best when raised in the nursery for one wood is heavy, exceedingly hard and strong, very durable act with the soil, and is used in ship building, turnery and uction. It is preferred for tree nails, and makes good railes.

White Ash (*Fraxinus americana*).

tree prefers to grow on rich, moist bottom lands, where be found mixed with elm, basswood, yellow birch and It will grow in a wet swamp and equally on dry, exposed so that it may be said to be versatile in habit.

quite tolerant when young, but when too much shaded meter growth is very slow.

e seed is produced each year, but abundantly only once in ears. It is quite easy to collect, and the tree is therefore ed quite extensively in forest planting.

rate of growth is rapid when compared with that of most associated hardwoods, but it varies considerably according ditions of moisture and situation. Post timber may be ed from it in from fifteen to twenty years.

te ash is attacked by a number of fungous diseases, which the leaves and flowers, but not sufficiently to kill the trees. the distinction of being the only deciduous tree which the moth does not attack, although there have been cases this pest has attacked this tree when everything else was

wood is tough and elastic, and this, combined with its to take a good polish and to season without injury, makes nber of exceptional value for furniture, car vehicles, manu-, interior woodwork, agricultural implements and tools.

tations will do best in a protected valley on a light loam.

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APPLICATION

FOR AN

EXAMINATION OF LANDS SUITAB
FOR REFORESTATION

TO THE

MASSACHUSETTS STATE FORESTER,
6 BEACON STREET, BOSTON.

The State Forester is empowered, under chapter 478
to accept, on behalf of the Commonwealth, gifts of land
managed for the purpose of experiment and illustration
agement and for reforestation.

The owners of land acquired under this act, or thei
signs, may redeem the land from the Commonwealth at
ten years, upon payment to the Commonwealth of the an
in improvements and maintenance; provided, however,
be included in the deed of reconveyance a restriction re
the future the cutting of trees on this land shall be in
modern forestry methods.

"SECTION 8. The state forester shall re-plant or oth
all land acquired by the Commonwealth and held by it
visions of this act, in such manner as will, in his judgme
best forest growth both as to practical forestry results
of water supplies."

Upon receipt, this request will be placed on file, and
formed, in order of application, approximately when t
can be made, and a mutual date can then be decided u

It is always more satisfactory to personally meet on t
owner or party most interested. In this way a definite
can be had as to future undertakings.

When sending in this application, a brief description
assist us.

With the above understanding, I desire to have an ex

of a tract or tracts of land of approximately............

in the town of..................county of............
Massachusetts.

Signed..................

Address..................

Date.......................19 .

FORESTRY
COLLEGE OF AGRICULTURE
UNIVERSITY OF CALIFORNIA
16

io Agricultural Experiment Station.

CIRCULAR NO. 110

WOOSTER, OHIO, FEBRUARY 25, 1911

TREATMENT OF ARTIFICIAL TREE PLANTATIONS

By EDMUND SECREST

ificial tree plantations of certain species in a highly special-
nmonwealth like Ohio require a radically different system
gement from that ordinarily applied to forest areas. With
f these plantations the same care and culture given to ordin-
d crops are applicable and profitable for the first few years
existance. Before attempting to establish a tree plantation
uld resolve to give it care and remain firm in the resolution
lay of time and money is required at the outset, in order to
success. One need not expect results by merely planting the
nd allowing them to care for themselves.

CULTURE

der this head the more common trees planted throughout the
tural regions of the state will be considered. Trees always
ster under cultivation than in sod, or when allowed to compete
eeds and brush. Whenever possible clean cultivation gives
sults, and the trees should be spaced to permit of this. In
to facilitate cultivation and pay for the cost, a crop may be
between the rows for the first year or two. For this purpose
s or legumes are best. Corn is not suitable. Cultivation
carried on in the same manner as for any field crop, and
be started as soon as necessary after planting. The period
vation will vary with species and conditions, but it should be
on as long as possible. Most species commonly grown can
vated for three seasons. Care should be taken the third
however, as by this time the root systems of the trees are
ed, and deep tillage may destroy the young fibrous roots,
s do more harm than good. A five or seven toothed culti-
r spring toothed or disc harrow, are desirable implements at
ie. When the rows are wider apart one way than the other,

tillage can be carried on to greater advantage, althoug both ways is more effective. At the cessation of this cover crop may be sown. For this purpose buckwheat clover are desirable. The first and last can be sow August and cow peas in the spring. The crop should to fall and form a mulch. This material, however, m away from the trees a foot or two in the fall, in order to danger of mice injury.

In case of locusts, cultivation for more than one doubtful utility, on account of the propensity of the spe up root suckers.

MULCHING

This system of cultivation is a valuable supplem cultivation and can be utilized in cases where such impossible or impracticable. Any vegetable material but wheat straw will probably be found the easiest to mulch material should be placed about each tree for three or four feet, leaving a space next to the tree bare two.

PRUNING

The Catalpa. In the case of this species, judicio one of the fundamental requisites of success. The c self pruning as are some of the common forest tree planting does not serve to clear the trunks of br advisable in most cases to cut the seedlings off an inch the root collar before planting, thus insuring a straigh the outset. This is desirable where the stems have b the nursery row, or after heeling in. Usually two or result and all but the most thrifty should be removed a a few inches high. The practice of cutting the trees o are two or more years old should not be followed, exc cases. The extremely rapid and succulent growth o resulting from the well developed root system, cannot heavy foliage, and consequently places the entire grove of the wind and rain storms. Many of the trees beco and worthless. The same condition is liable to result branches are removed, leaving only the stem. Lateral necessary to obtain diameter growth and diamete necessary in order that the tree may support its to tree is the one having a smooth, straight trunk. T cannot be obtained by severe pruning. A tree rec argely through its leaves, and consequently growth n leaf surface. The fundamental principal to be observed is the ination of forks and the securing of straight trunks, bearing in d that the smaller side branches are an asset rather than a iment. They should be removed however as soon as they die.

Catalpa trees are frequently injured by freezing or by the lpa midge (see bulletin 190) and develop three or four side nches, with no terminal shoot. If possible it is best to let one of lateral branches form the central stem, and remove the others. en this is not feasible the entire crown may be severed, allowing rout from this point to form the terminal. It is necessary, in ain cases, where trees are distorted to cut them off at the und. When such procedure is necessary all sprouts may be wed to grow for the first season, and all but the most thrifty oved the following winter. In some cases all sprouts may be oved when a foot high, except the most thrifty, which should taked to prevent breaking off, or becoming distorted. In other s it may be desirable to allow several sprouts to mature. re should be no hesitancy in cutting off crooked or distorted s, which cannot be corrected by pruning. The remaining trees afford protection against wind and other disturbing elements.

Where severe pruning has been practiced and the trees are in ger of bending over it is sometimes advisable to strip the leaves he top for a foot or two. The leaves should never be stripped ess such danger is imminent. When trees three or four years of are entirely pruned of side branches they become top heavy and siderable injury may result. This practice should never be mitted.

THE LOCUST

Unlike the catalpa, the locust is self pruning and the only ration necessary is the removal of branches which form forked nks. This procedure is important and should not be neglected n the outset. The pruning of lateral branches, as in the case of lpa, is not only unnecessary but detrimental. As soon as the s commence to crowd, the limbs die and drop off. The tops of seedlings trees may be cut off at the time of transplanting, but er thereafter unless injured. The spreading habit of the young s in a grove need cause no apprehension, for in the course of e they will straighten and develop into merchantable trees.

THE OSAGE ORANGE

The species is not self pruning, and owing to its tolerance to le the lateral branches do not die quickly when the light is uded Careful attention should be given to the elimination of ed trunks and the lateral branches, as soon as they die.

Because of the difficulty in pruning due to thorns, to plant the rows farther apart and the trees closer to rows. Such spacing will also facilitate cultivation, wh carried on for at least three seasons.

THE MULBERRY

The various species of mulberry are similar in ha and character to the osage orange and may be treated manner as prescribed for the latter. Some of the m subject to winter killing to the extent that they die e the ground. Like the osage, they are excellent purposes, and may be used about buildings, groves an this effect.

OTHER FOREST TREES

Plantations of ash, tulip poplar, oaks, walnut, practically all of the native trees are self pruning, and of dead lateral branches is usually all that is required, cases this operation may be of doubtful utility. The cypress, which are exotics, may also be included The former species is inclined to retain its dead branc may often be profitably removed.

EVERGREENS

The tops of pines, spruces and cedars should ne It is usually advisable to prune only dead branches. pines, this is usually quite practicable. Evergreens but in such event, one of the branches should be remov tree is small.

GENERAL CONSIDERATIONS IN PRUNING

TIME OF PRUNING

The proverbial saying, "Prune when the knife probably correct, although it does not seem desirabl late summer. The winter months offer the most op and in most respects are the best period for such prefer the months of February and March. Wound time begin to heal quickly and have the whole growi which to continue the process.

TOOLS

More important than the time of pruning is the made. The cut should be clean and smooth. Ragged almost as bad for trees as for human beings. Care s be taken not to tear the bark of the trunk. Severing to the trunk is injurious and makes a larger wound. Likewise t may be made too far out, leaving a stub which prevents a bole and serves as an entering place for fungus diseases and s.

he selection of a tool will depend upon the nature of the work. oung trees having small branches, a sharp pocket or pruning is very practicable. Larger limbs require a chisel, pruning s or axe. Rightly used the axe may be found to be the most cable of all, but it must be sharp. Various patent pruners the market, some of which are very satisfactory. Some are ally adapted for pruning limbs high in the tree. A chisel ed to a pole may also be used for this purpose.

he number of seasons during which trees may be practicably ated will vary according to conditions of soil and site.

pproximate period of cultivation for the common forest trees ficial plantations: Locust, 1 to 2; Catalpa, Mulberry, Poplar, oft Maple, 3 to 4. Ash, Larch and Tulip Poplar, 2 to 5; ss, Osage Orange and Pines, 4 to 5; Black Walnut, and Hard , 4 to 6.

he system of treatment, especially as regards cultivation, s only to the small farm tree plantations where conditions of lture demand intensive methods. In larger operations of station in parts of the state they would often not be applicable

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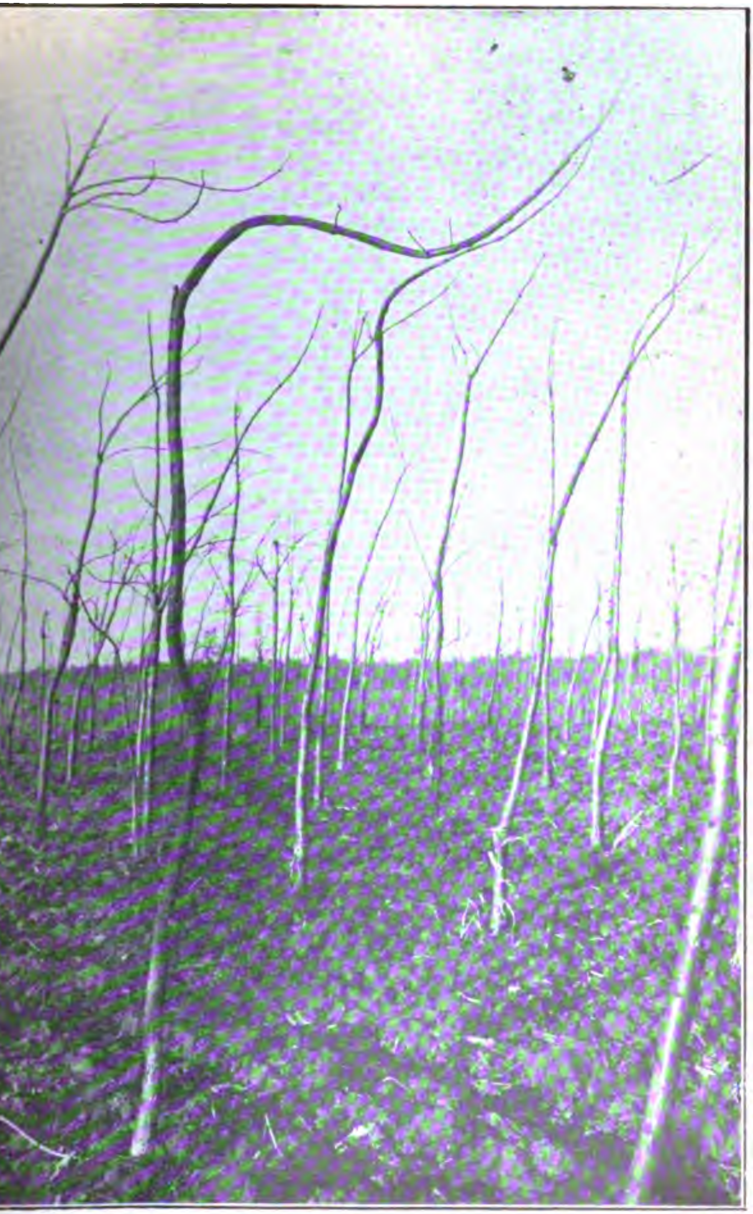
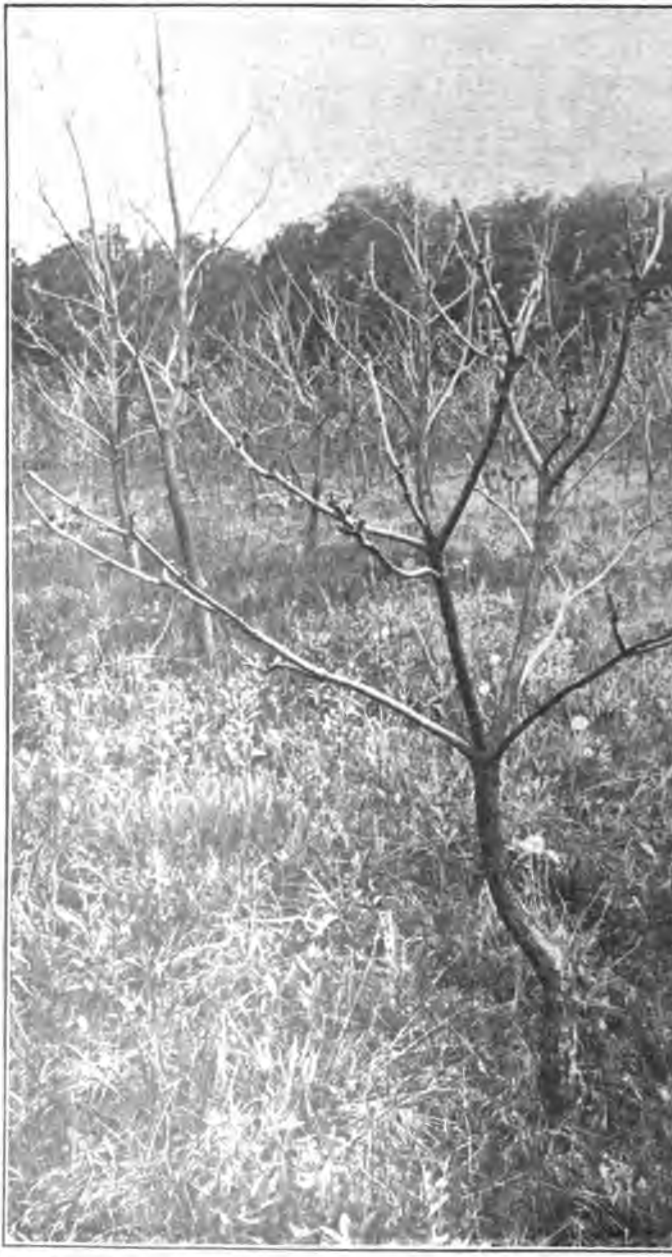
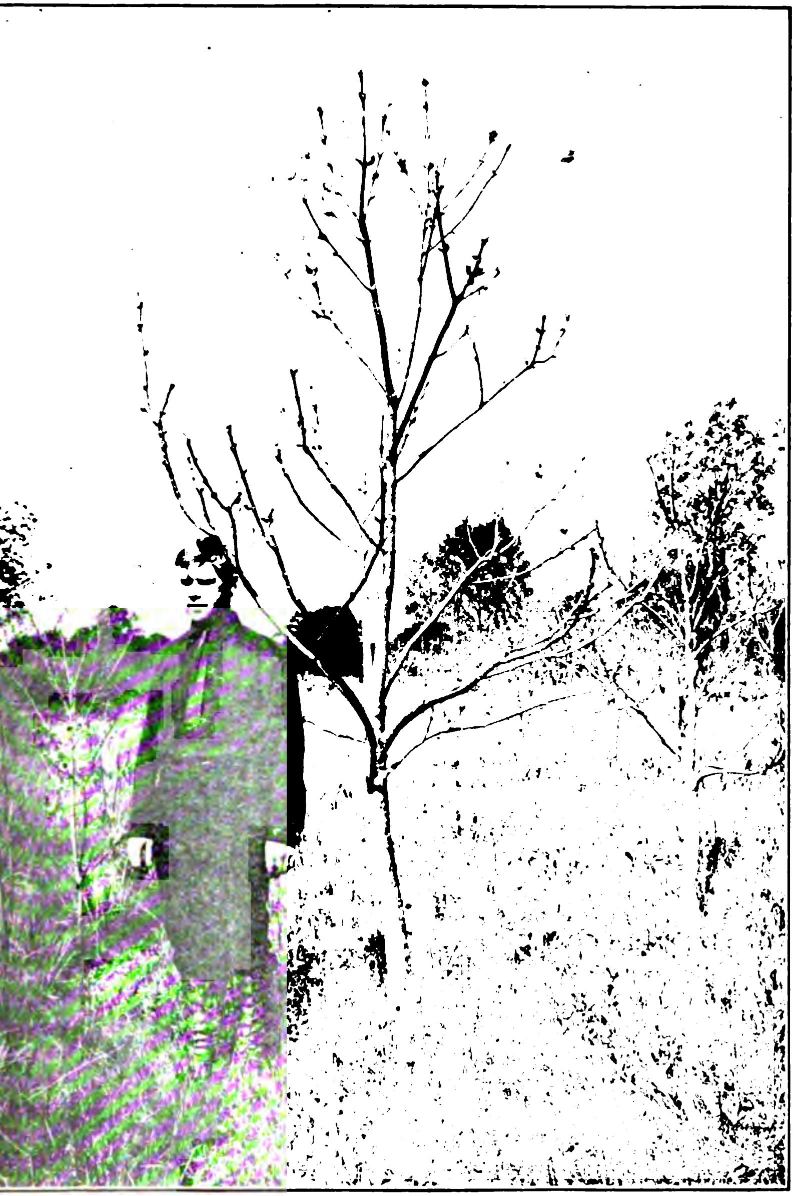


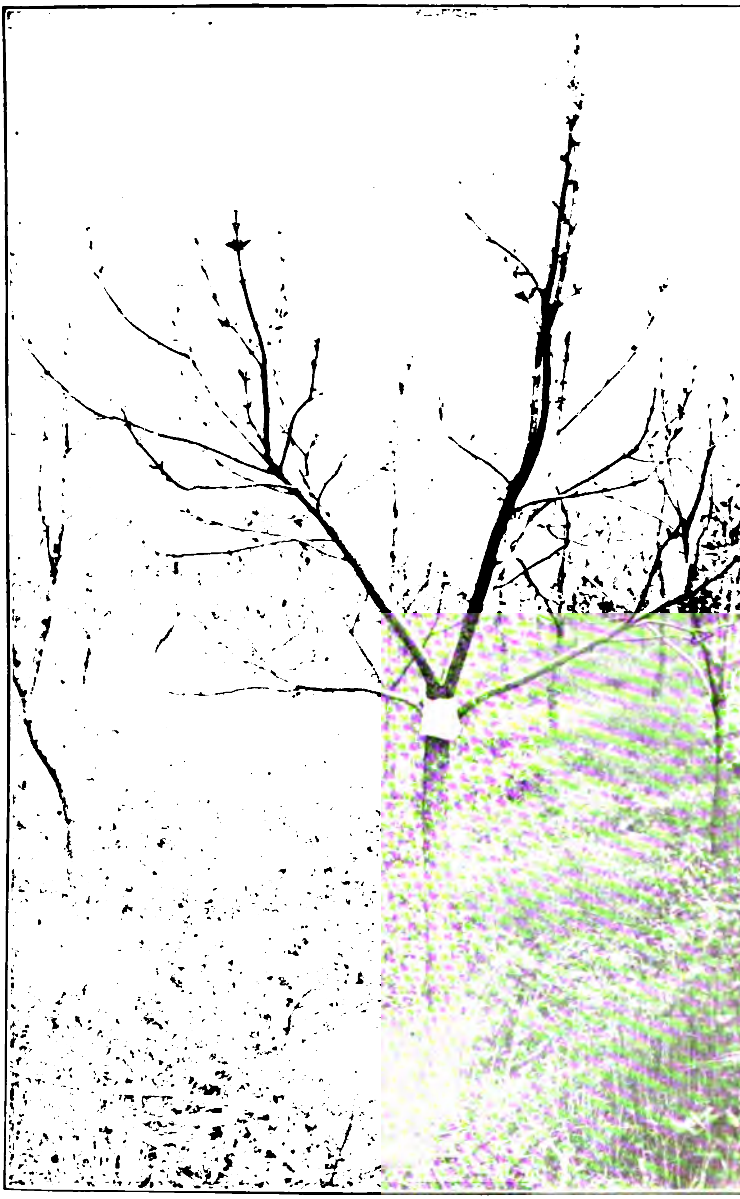
Distortion of catalpa as a result of severe pruning



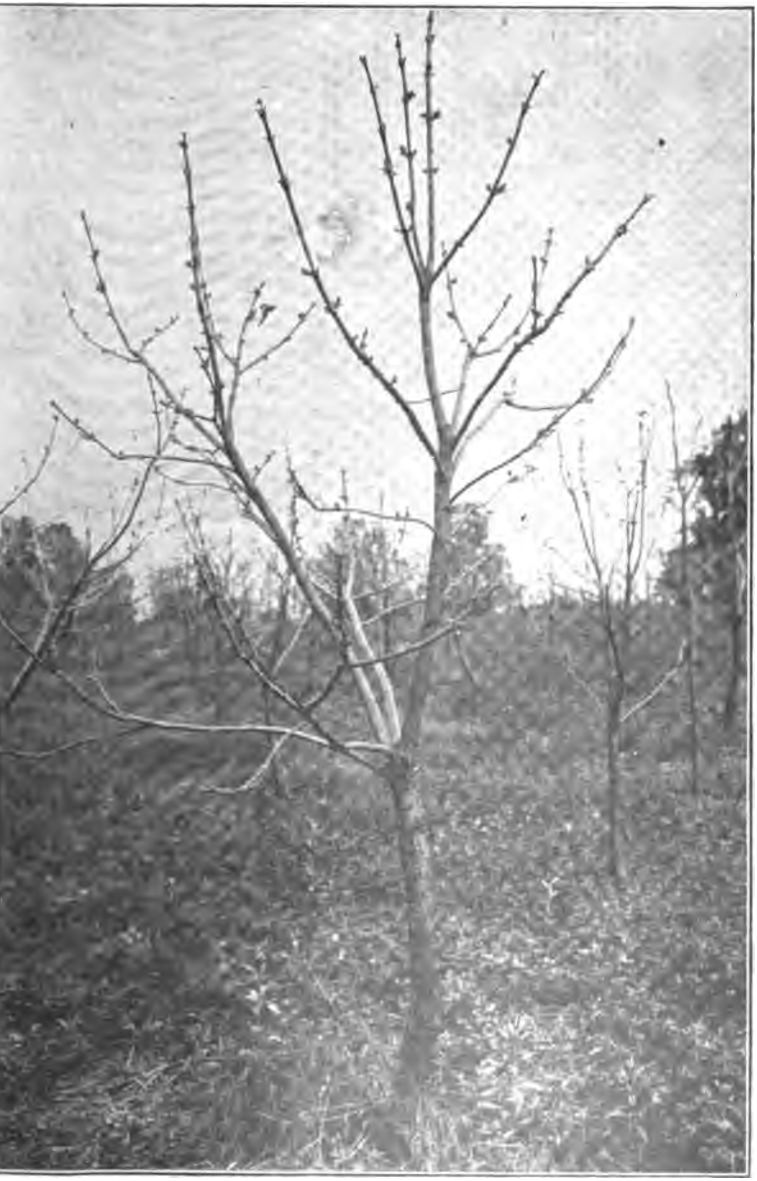
A catalpa which should be cut off at the ground. The sprout
cared for will be straight



A normal catalpa. One of the branches of the upper fork should be removed leaving the lateral branches to furnish leaf surface



The entire top of the catalpa tree should be severed from the trunk, at th
indicated by the cloth. The thriftiest sprout starting at this poin
should form the leader, thus saving the four foot trunk



catalpa, which may be corrected by pruning. Such trees should not be cut off at the ground

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A locust plantation, in which all forks have been removed from t
The smaller side branches were killed by shading, and have d

The wide distance of planting black locust, has permitted a spreading habit of growth

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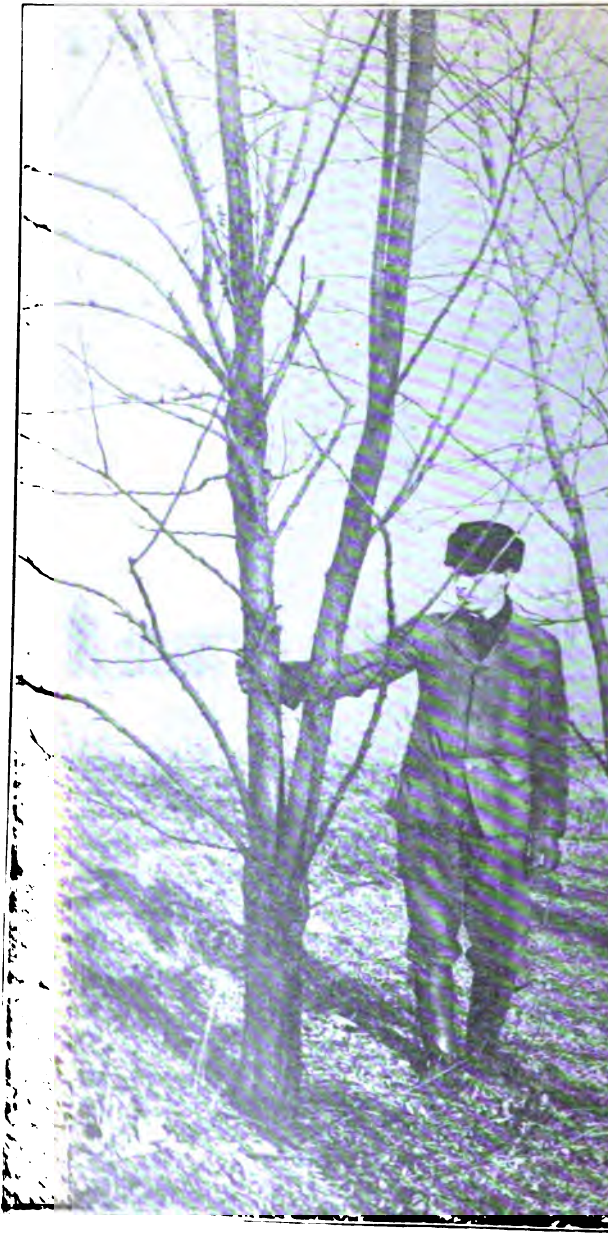
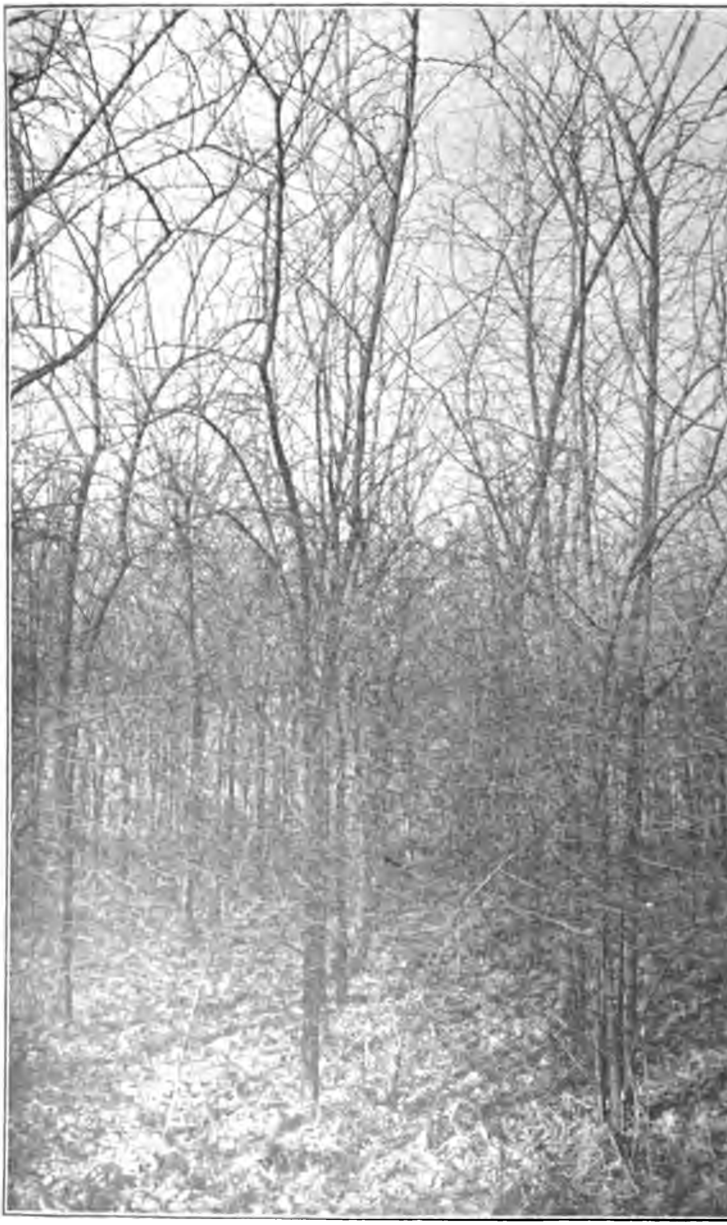


One of the branches of the black locust, forming the for
should have been removed when the tree was two
or three years old. Most of the side
branches shown are dead



An osage orange plantation. The close planting has forced the growt
but has resulted in but little natural pruning

ite ash plantation in excellent condition. The small side branches will die and fall as the trees develop

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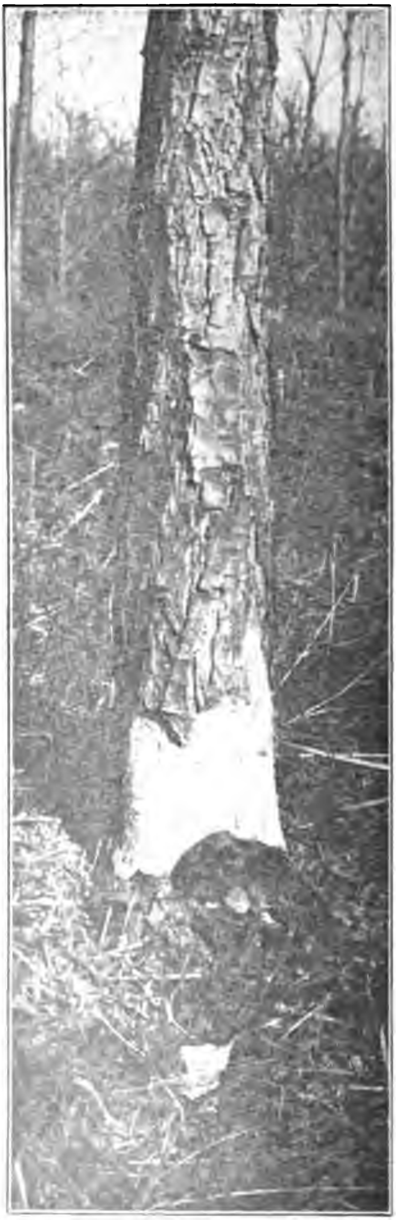

A catalpa five inches in diameter girdled by mice

Russian mulberry injured by mice

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SUGGESTIONS FOR THE OBSERVANCE OF
ARBOR DAY

BY THE

PUBLIC SCHOOLS OF MAINE

WITH SUGGESTIONS FOR SELECTING
AND PLANTING TREES

PREPARED BY

GORDON E. TOWER, M. F.
DEPARTMENT OF FORESTRY
UNIVERSITY OF MAINE

ISSUED JOINTLY BY THE

MAINE FORESTRY AND EDUCATIONAL
DEPARTMENTS

ARBOR DAY

By

GORDON E. TOWER, M. F.,
Professor of Forestry, University of Maine.

The idea of having a day set aside to be devoted to the plant-
of trees originated with Governor J. Sterling Morton, of
braska, the idea taking concrete form in 1872 when the State
ard of Agriculture of that state appointed a day as Arbor
y. From that time on the movement gained favor until now
day is observed by every state in the Union.

The chief lesson which has come down to us from the past
servance of Arbor Day is that it is a day set aside for the
nting of trees with the work centered largely, if not entirely,
setting out individual trees for ornamental purposes. In the
ort to make Arbor day serve a useful purpose in the forestry
vement, this feature has been made the most prominent so
at many people still believe that forestry consists only in the
nting of trees.

The true significance of trees in the life of the nation has
en lost sight of in poetry and sentimentalism which have char-
erized the exercises of the day, and instead of directing the
ention of business men to the larger economic and practical
estions involved in forestry, have made them regard the
vement only as a fad.

The planting of individual trees can rightly be made one of
chief features. The exercises, too, can center about the
nting but they should be so planned and selected as to bring
the pupil's attention in a simple, direct way other facts than
erely how to plant the tree and care for it. The isolated trees
nted along the roadside and in the city streets give an added
arm and beauty; those around our houses are not only beauti-
in themselves but they furnish refreshing shade in the sum-
er and in the winter may even save on the fuel burned by pro-

tecting our houses from the cold winds. As a feature of the day proper attention should be directed to the planting for such purposes.

The tree that is of greatest significance to us as a nation, however, is the forest tree, because it serves so many useful purposes. It is our forest trees which help to hold back and store up the water for our streams which supply power for mills and which are used for navigation, or from which water for irrigation and drinking purposes is obtained. Then, too, the harvesting and conversion of the products of the forest every year furnishes employment to many thousand people. In fact it is the tree in the forest which has made our state prosperous and we must, therefore, give more and better attention to the forest trees if we are to continue to maintain our place in the nation.

It is this idea that is the basis of forestry, and that is kept in mind when forestry is practiced. Here then is the truer and broader lesson of Arbor Day and with this in mind the aim should be to impart, especially to the children, such knowledge of forestry and its relation to the welfare of the nation as their minds are capable of grasping. However modest the work of Arbor Day, it may be made a step in the right direction by bringing to mind a great many important facts of significance in forestry.

Suggestions for Arbor Day.

The relation of the forest to the regularity of flow of streams can be made a subject for discussion. The attention of the pupils can be called to the washing away of the soil and the formation of deep gullies on steep hillsides where the forests have been removed and if the soil is thin how it is often completely washed away leaving nothing but the bare rock. Then how this soil is carried into the streams causing the muddy freshet in the spring and after a heavy rain storm; and how the load of silt and sand carried by the water is deposited in the channel of the stream and is even carried down to fill up our harbors so that, in the latter instance, much costly dredging is necessary in order to keep the harbor passable for ships. The washing of the soil can be seen on any steep exposed embankment and on plowed hillsides.

One or two simple experiments may be performed by way of lustration. A little soil may be stirred in a glass of water and ien allowed to settle to show how the stream remains muddy hen it flows swiftly, and how the load of silt and sand which it rries settles to the bottom in the more level portions of the ream.

The great value of the forest on the mountain slope and on eep hillsides can be illustrated by means of a board 12, 14, or 5 inches wide and 2 or 3 feet long placed at an incline on a ble. Then with a garden sprinkling can pour water on the oard and see how quickly it runs off. Next put some soil on e board and pour water on this. The soil at first takes up e water until it becomes saturated and then if we continue pour on the water the soil begins to wash away just as it oes on the mountain slope when the forest is gone. Now, re-ew the soil on the board and put over it a layer of fine sawdust finely divided vegetable matter from the woods to represent e layer of leaves and humus in the forest; then pour the water er this with the sprinkling can. After a time the water be-ns to trickle out from the lower edge of the soil and its cov-ing, and runs off gradually. This will serve to illustrate how e layer of leaves and humus acts as a sponge to absorb the rain nd store it up in the soil to appear later in the form of numer-us springs to feed the streams long after the wet season is ast, thus regulating their flow and furnishing a supply of ater during the dry season.

The teacher can carry the illustration still another step farther holding a few small branches of fir, spruce, or pine above the oard in imitation of the canopy formed by the branches of the ees to show how the trees dissipate the force of the rain as it lls, and prevent the evaporation of moisture from the forest il so that more of it sinks into the ground to appear later in e form of living springs.

The many uses of wood can be made the basis for subjects for rbor Day compositions or short talks by the teachers. With e exception of air and water, wood is the most abundant of ature's gifts offered for man's use. We can form no idea of e hardships that would have to be incurred by us as a nation we were suddenly deprived of our supply of wood. The ouses in which we live are largely made of wood and the fuel commonly used to warm them is wood. Even the match used to kindle the fire or light the lamp is largely made of wood. The material for tables, chairs, and desks in the house, for the wooden parts of carriages and wagons, for the handles of axes, shovels, rakes, and a hundred other implements in common use as well as that for paper stock for books and newspapers is taken from the forest.

In comparison with iron or stone, wood is easy to procure and easy to work, and easy to place in position. This fact alone makes it especially desirable to say nothing of the pleasing effects to be secured from wood when it is properly polished, filled, and covered with a transparent material like varnish.

Likewise the flowers and seeds of trees are interesting subjects for compositions by the pupils or talks by the teacher and can well be made a field for investigation at other times than on Arbor Day. Even though flowers of the trees may not be available on Arbor Day, there are many interesting facts of botany which might be mentioned and discussed at that time. There are some trees which produce perfect flowers that pollenize their own pistils as for instance the black locust and basswood; other trees like the pines, spruces, beech, and oaks produce the two kinds of flowers, staminate and pistillate, separately on the same tree while trees like the willows, cottonwoods, and ashes produce the pistillate flowers on one tree and the staminate on another. In the case of the last two classes the means by which the pollenization is accomplished at once suggests another most interesting subject, namely, how the pollen is blown by the wind or carried by insects and the many interesting and even intricate devices of nature to secure and insure pollenization.

There are different adaptations for the distribution of the seeds. Some, like the pines, spruces, and maples, are provided with a wing so that they are carried by the wind; seeds of the cottonwoods and poplars are very small with a fuzzy thread-like attachment that is very buoyant so that the seeds are often transported long distances through the air. Some seeds are produced in a pod, the honey locust being an interesting example. The pods of this tree on drying become twisted spirally so that when they fall to the ground or on the snow they are more easily blown about by the wind, especially if there happens

be a crust on the snow. The seed of the wild cherry, for
xample, is distributed by birds which eat the fruit to get the
dible pulp surrounding the seed. And then there are some
eds like those of the oaks, hickories and butternuts which are
eavy and are not easily distributed except perhaps by man or
nimals like the squirrel. In the fall of the year when so many
eds mature, a collection could be made by the teacher to be
sed for illustration of an Arbor Day talk.

Forestry is also a good field for nature studies and the interest
the day can be made keener and the value of the instruction
uch greater if some nature study can be carried on during the
hool year. Besides the trees in the woods, there are the beau-
ful flowers and other vegetation of almost endless variety as-
ciated with the forest growth, the insects, birds, and animals
at dwell in the forest, all of which charms the youthful mind
nd forms an excellent opportunity to stimulate the faculty of
vestigation in the pupil, leading them into fields of their own
scovering, besides being a means of keeping the youthful fac-
ties in touch with the world of reality.

A collection of tree seeds can be made by the children in the
ring or fall, the latter time perhaps being preferable because
the larger number of different kinds of seeds which mature
that time. These could be planted at school in window boxes
here their growth could be watched during the winter or out
doors in a bed in the school garden; or if the school is not so
rtunate as to possess one, in a bed prepared especially for the
rpose. Some seed like that of the pines and the spruces for
stance must undergo a short resting period before germinating.
eed of this kind could be stored in sacks in a cool, dry place
nd sown in the window boxes in February or March or re-
rved for the outdoor sowing. Such seed would be all right
sown in the boxes in the fall, because that is nature's time for
wing, and would germinate after a time, provided the soil is
ept moist. Even when sown under the most favorable condi-
ons it is often two weeks before such seed commences to ger-
inate. In fact with a good many different kinds of tree seed
longer time is required for them to start than is the case of
rn, wheat or garden seeds.

Suggestions for Planting.

Planting may be done in the fall after the growth of the season is completed or in the spring before growth begins. Planting in the spring may begin as soon as the frost is out of the ground enough to permit the trees being set at the proper depth.

It would be better also if the planting could be done on cool damp days. Sunny, windy days increase the danger of injury if the roots become unduly exposed.

A thing of fundamental importance to the success of the planting work is never to leave the roots exposed. If the trees are procured from the woods or fields in the immediate vicinity certain rules should be observed.

1. Procure as much of the root system as possible with trees under three feet in height. With larger trees procure as much of the root system as can be conveniently handled.
2. Dig the trees out. Do not pull them up as it is very apt to injure the roots.
3. As soon as a tree is removed measures should immediately be taken to protect the roots. This can be done by covering with moist soil or wet burlap.
4. Keep the roots protected all the time while the trees are being transported to the place where they are to be set out and until ready to place in the ground. Wet burlap sacks are excellent for this purpose. For small trees which could be carried in a basket, damp sphagnum moss, or even damp leaves could be used instead of the burlap. Whatever material is used, care should be taken to keep it damp.
5. Set the trees so that they will be at the same depth as in their original position *after the soil has settled.*
6. Never prune the tops of conifers.

If the trees can be taken up with a ball of earth about the roots it will add materially to the success of the work, and the precautions mentioned to prevent the drying out of the roots are not then so important. It would be well, however, to wrap the ball of earth with burlap to hold the soil in place. It should be remembered also that seedlings which have been accustomed to growing in more or less shade do not, as a rule, succeed as well at first when given the full benefit of the sunlight.

If the trees are purchased of a nurseryman they should be npacked as soon as received, and the roots protected by "heelg in" the trees, that is, burying the roots in fresh soil until me to plant. This will not be necessary, of course, if the anting can be done at once.

By arranging with some owner to plant a few trees in a field isuited for raising crops or on an area cut over in the woods, even a row of trees to serve as a windbreak, would broaden e scope of the work. And no matter how few trees were set it it serves to illustrate planting for practical purposes. In is way the work could be done just as it is in commercial anting.

Arbor Day is not the only time of year when trees should be red for and remembered. Newly planted trees, especially, ed attention throughout the season. The ruthless injury done trees by children, sometimes of such a nature as often to beme an act of vandalism, needs to be discouraged at all times. broken limb or wound in the bark makes an opening where ngerous insects may enter, or fungus diseases get a start, ther of which might eventually cause the death of the tree.

SOME CONIFEROUS TREES SUITABLE FOR ORNAMENTAL PLANTING.

NATIVE SPECIES.

WHITE PINE makes its best development on fertile, well-drained soils but will grow on sandy soils and in moist situations.

RED SPRUCE grows best on well drained upland soils. It is often found in moist places and on thin soils but in the latter situation does not make its best development.

HEMLOCK prefers moist, cool, and shady places, and a sandy loam soil for its best development, but like other trees will grow in poorer situations.

RED OR NORWAY PINE is naturally adapted to grow on poor sandy soil. When planted on richer soils it makes a more rapid development. It should not be planted in wet places or in soil which is not well drained.

INTRODUCED SPECIES.

AUSTRIAN PINE grows well on sandy loam, or clay loam soils having a good drainage and will also make a good development on poorer soils if there is good drainage. It cannot be expected to succeed in wet places.

SCOTCH PINE grows naturally on poor soils but can be planted on fertile sandy loam soils of good drainage. Like the Austrian Pine it should not be planted in wet soil.

NORWAY SPRUCE succeeds best on fertile, fresh, sandy loam soil. It is used very extensively in ornamental planting.

EUROPEAN LARCH. This tree can be planted on poor sandy soils or on better soil of a sandy loam character. As a general thing it is much better for planting than our native larch.

SOME DECIDUOUS TREES SUITABLE FOR ORNAMENTAL PLANTING.

NATIVE SPECIES.

WHITE BIRCH thrives best in a rich moist soil.

BEECH requires a rich upland soil for its best development hough it is found growing naturally on ridges having a shal- v soil.

RED OAK succeeds best in rich upland soil but will grow in ıer kinds of soils and situations, even on the poor thin soil of lges.

AMERICAN ELM prefers rich bottom lands and the moist l along streams. It grows well, however, in fresh, fertile soil higher land back from streams.

SUGAR MAPLE makes its best development on rich, moist, land soils.

SILVER MAPLE grows naturally on sandy banks along eams but does very well in most sandy loam soil on higher ound.

RED MAPLE is naturally a swamp tree and therefore adapt- for planting in wet places. It can be expected to succeed ry well on higher ground in moist sandy loam or clay loam ils.

BASSWOOD requires a rich soil for its best development.

WHITE ASH succeeds well on rich, rather moist soil of low lls and can be planted in fairly wet soil.

Trees Suitable for Windbreaks...

White pine
Red Spruce
Norway spruce

Trees That Would Be Used In Commercial Planting.

White pine
Red spruce
Red pine
Red oak
Red maple
White ash
European larch

References.

The following list of books and circulars is appended because of the help they may be to the teacher in suggesting subjects for talks to the pupils:

Gifford, Practical Forestry, Putnam, $2.00.

Roth, First Book of Forestry, Ginn, 90 cents.

Marsh, The Earth as Modified by Human Action, Scribner, $3.50.

Forest Service Circular 130—Forestry in the Public Schools. Government Printing Office, free.

Forest Service Circular 14—What Forestry has Done, Government Printing Office, free.

Apgar, Trees of the Northern United States (Botany), American Book Co., $1.00.

Dame & Brooks, Handbook of Trees of New England, (Botany), Ginn, $1.50.

The department will be glad to render all assistance possible and invites correspondence from any one desiring further information. Address all communications to Gordon E. Tower, Orono, Maine.

Walter Mulford

THE UNIVERSITY OF NEBRASKA

Agricultural Experiment Station

DEPARTMENT OF FORESTRY

CIRCULAR No. 1

Cooperative Experiments in Forest Planting

By FRANK J. PHILLIPS, Forester

Distributed September 1, 1909

LINCOLN, NEBRASKA
U. S. A.

OOPERATIVE EXPERIMENTS IN FOREST PLANTING

Introduction.

Nebraska is justly noted for its interest in forestry.
t was the first of the Great Plains states to establish exten-
ive forest plantations and it still retains its position in the
ront rank of prairie states in this respect. The need for
helter, beauty and timber supplies induced the early settlers
plant as soon as they located permanently. The govern-
ent tree planting act of 1873 produced more extensive plant-
g and better results in this State than in any other. Arbor
ay, which was founded by the late Hon. J. Sterling Morton
nd is observed by every state in the Union as well as in the
ost progressive foreign countries, has added greatly to Ne-
raska's fame. The Bruner Brothers' plantation in Holt
ounty, the extensive work of the United States Forest Ser-
ice in afforesting the sandhills and the large number of indi-
iduals who are establishing pine plantations in that region
ave added another stage to progressive forestry work and to
estern planting in particular. Planting in the eastern part
f the State has been increased thru the fact that a large
umber of plantations have been found to give excellent
rofits. Moreover, there is a strong tendency thruout
he State, which has developed within the last two years, to
lant trees on such lands as are unsuited to agriculture but
re capable of producing good forest growth. There is also
strong tendency for prosperous farmers to plant small groves
r shelter belts with the idea of permanently improving their
roperty as well as making the State one of the most beauti-
ul in the West.

Need of Experimental Work.

Despite the large amount of work already done, there
need for comprehensive experiments thruout the ent
State. It has been fairly well proven what species native
the United States will succeed in this State, while many e
cellent studies have been made of the rate of growth, yie
and profits from many of the best plantations. In most
this work, however, the plantations have been measured o
ly once during their existence. Naturally much more acc
rate and far better results would be secured if these pla
tations were measured every year or at longer intervals, d
pending upon the character of the plantation. Thus it h
not been determined whether any plantation in the Sta
would have given a greater yield if cut at some number
years before the measurements were taken or whether
would have produced greater results if retained for a long
period of growth.

Little work has been done on classifying the various si
which may be used for forest growth. It is well known th
a difference in soil, in soil moisture, in elevation and in c
mate materially affects the production of timber. In fore
plantations such effects as these may be very accurate
measured.

A still greater factor which needs extensive investigati
is the profit that may be secured from forest planting. It
probable that no plantation in the State has been more ca
fully accounted for than the C. D. Robinson plantation
hardy catalpa at Pawnee City. Every item of expense a
all receipts were carefully recorded with the result that,
ter allowing five per cent compound interest, the plantati
paid $6.40 per acre per year. However, in practically all t
plantations thruout the State no record has been kept
expenses and only a general idea may be had as to wheth
or not a given plantation has produced a profit. Such mea
information necessitates a large amount of hypothetical wo
which should be replaced by careful records of every item
expense and of receipt. Likewise, it has been a very co

mon practice to estimate the amount of material in plantations, often from very crude measurements. There is need for exact measurements at various periods while the trees are standing, followed by an exact determination of yields when the plantations are cut.

The results of spacing and thinning are almost unknown even for those species which have been of greatest use in the State. For example, from plantations already established, it would seem that a spacing of four by four to six by six is best suited for hardy catalpa but it has often been argued that a spacing of eight by eight would succed better. Since the most profitable plantations or parts of plantations have been those which have yielded the largest amounts of high class products in the shortest time, the importance of spacing and thinning may be readily recognized. It is aimed to establish type plantations of the various species on sites best suited to their growth in which the effect of spacing will be definitely proven. The greatest factor in this respect is to determine the effect on yield and class of products.

There are numerous other problems of great importance to the State, such as the preservative treatment of short-lived fence posts, the possibility of growing osier willows over large areas of moist or wet soils for basket purposes, the seasoning of cottonwood lumber, extending the planting range of hardy catalpa, planting on poor soils, planting on slope lands and along stream courses, and a more detailed study of the effects of windbreaks. These are but a few of the more important questions which the Experiment Station desires to work out and which should be investigated in the near future.

Need of Cooperation.

At the State Experiment Station an area of twenty acres is devoted to such work, while at North Platte an area of twenty-five acres is being devoted to similiar purposes. However, there is need for a much larger acreage than the Experiment Station can afford to devote to this work and, so far as possible, it is aimed to distribute these plantations

rather than confine the work to land controlled
periment Station. Several farmers have alread
the cooperative agreement and have started thei
It is aimed to start such plantations in various p
State and ultimately they should prove of value
in every county. It is also desired to secure r
on the best plantations which have already beer

Nature of Cooperation.

The Forester of the Experiment Station is t
nite plans for each experiment, while the far
tablish the plantation and care for it. In no c
practical experiments be conducted or systems
ment be devised which will entail any s
ship. It will be the aim of the Forester to visit
sible, each area that is planted and to visit the
definite intervals after it is established in order
curate measurements and to determine exactly
the planting at various stages of growth. It
have at least five acres in each experimental pl
greater area will allow more definite results.

The farmer is to keep an account of all
spends on the plantation in return for the expe
will receive in establishing the plantation and f
sequent visits of the Forester. From time to
will be published in which credit will be given t
who has maintained such a plantation. It is re
the sale of lands, the desire to use a certain ar
purposes and other minor conditions may occas
it imperative for the owner to drop the coope
It is therefore agreed that either the owner or
ment Station may stop the experiment by g
notice to the other party concerned.

The last page should be detached and maile
ester of the Experiment Station by any owner
conduct such an experiment or to receive more
as to the work that is contemplated.

Detach and mail to: The Forester, State Experiment Station, Lincoln, Nebr.

Name of owner ....

Post office ....

Location of planting site ....

Character of soil and subsoil ....

....

....

Topography ....

Depth to water table ....

Purpose in planting (whether for windbreaks, fuel, lumber, fence posts or other purposes) ....

....

....

Acreage to plant ....

3

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UNIVERSITY OF ILLINOIS,

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THE FOREST TREE PLANTATION.

PRELIMINARY HISTORY.

The first official act in the establishment of this experiment was e report made to the Board of Trustees of the University by its ommittee on Horticulture, November 18, 1868. The members of the ommittee were Burden Pullen, Samuel Edwards, O. B. Galusha, L. Dunlap, and W. C. Flagg. The following is taken from the port :

> The great feature of these horticultural grounds, and what is of paramount im-ortance at this time to the whole people of the state, is the planting of forest trees r useful purposes. It is a new demand upon their industry and upon their lands, om which they cannot fail to reap the most valuable results.
>
> The new condition of things created by railroads and improved agricultural nplements presents new industries, both to the cultivators of the soil and to the echanic, in which they have a mutual interest. The forests are rapidly disap-earing, or at least those useful trees that have a commercial value, and yet many of e new demands have not been met nor is the old supply likely to hold out. But if e forests of Michigan, Wisconsin, Minnesota, and Indiana were adequate to the emand, as a matter of economy in freights, if not in the superior quality of our econd growth timber, especially of the deciduous varieties, it is an object to grow em at home rather than to buy them.
>
> Timber for railroad ties, culverts, cars, roadways, and buildings, fencing, vine-ard stakes, hop poles, stanchions for coal banks ; soft wood, like white willow and e poplars, for berry boxes, crates, and staves ; hoop poles, carriage and wagon aterial, agricultural implements, and the multiform wants of the age, make up a emand of most surprising magnitude, that will add to our rural industry an import-nce that the most sanguine have not heretofore dreamed of.
>
> If we look at this as simply the demand of agriculture, it must be conceded that is legitimate and ought to be granted without an objection ; but we have added to his the claim of the mechanic, who is also largely interested, for it will enable him compete with those of other states in the supply that commerce demands.
>
> The state that sells the raw products of its soil is never rich, while the states that anufacture for others do well ; those that grow the raw material and manufacture it t home are the most prosperous. No doubt the State of Illinois had these facts in iew when it established this great school of the industries for the especial benefit of hose two classes who create the wealth of the state.
>
> There are in this state about eighty species of forest trees, besides the larger hrubs. With the exception of the oaks, yellow poplar, and hickory, we have not rawn largely from our native forests, and to-day we purchase nearly all of our

timber. Nearly all of the ash timber used for agricultural impler
fence posts, and a portion of our railroad ties come from other stat
are the greater part of the material for our wagons and carriag
manufactured in other states; the timber for railroad cars, and th
for many other useful purposes, that ought to be grown near the pl

To bring these useful trees within the bounds of culture and t
of the objects of this industrial institution. To teach the people c
add these products of the forest to their other crops, and thus add
annually to the wealth of the state, to give labor a wider range a
hensive field for its employment, are objects worthy of such an ins

Thousands of acres of timber can be planted in shelter belts,
that come down from the north, with its polar cold, destroying
genial summer, fanned with the breath of the tropics, has mad
open plains. Wall in these prairies of central and northern Il
conifers and deciduous trees, and we shall have one of the best of
equable; and with the best soil in the Union, with a geographic
between the two oceans, over which must pass a large part of th
world, if we are not laggards in the world's progress we may reap f
ings a rich reward.

The committee has divided these thirty species of useful for
classes, according to their supposed value for the demands of
domestic use. In the first class they include the European larch,
Norway spruce, native trees of Europe, and the osage orange,
western states. In the second and third classes white willow, a nati
spruce and Norway pine, natives of the more northern states.
list with four European, three of other states, and twenty-thre
forests of Illinois.

Our other native trees of minor importance will find a plac
where those of other sections of this continent and of Europe may b
It is probable that among them may be found many of value.

First Class. European larch, osage orange, white pine, white
green ash, arborvitæ, blue ash, red cedar, Norway spruce.

Second Class. White sugar maple, black sugar maple, Ameri
bark hickory, cucumber, Norway pine, silver leaf maple, tulip,
walnut.

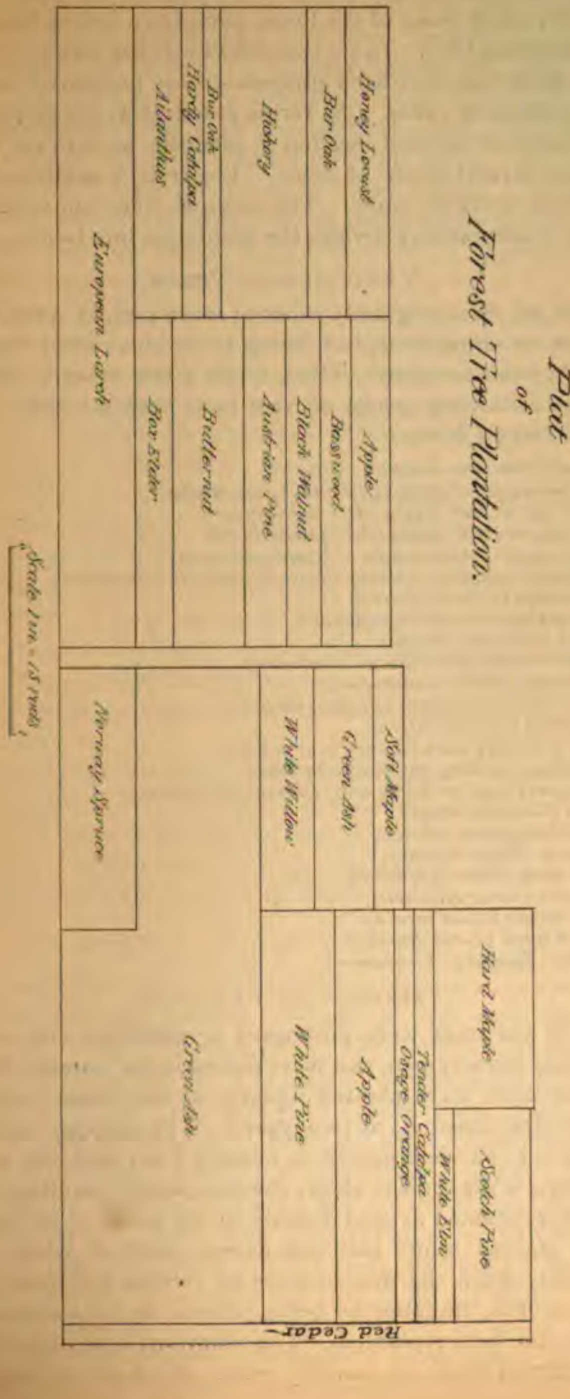
Third Class. Red maple, white elm, red elm, butternut,
basswood, white oak, black spruce, bur oak.

The white pine, Austrian pine, Norway spruce and hemlock
by eight feet: all others four by four feet. The former requiri
eighty trees to the acre, and the latter two thousand, seven hundre
above distances to be varied to some extent by way of experime
actual trial, the most proper distances for the planting of the sev

In accordance with this report an appropriation w
the state legislature, from which $1,000 was set apart,
for trees and seeds.

LOCATION OF PLANTATION AND CHARACTER

The experimental forest tree plantation of the U
gun in the spring of 1871; since then additional pla
made from time to time. It is located upon the ea
known as the experiment farm, and at present compris
acres planted. The land was originally prairie, but
cultivation for thirty or more years, mostly in corn.
had been too wet for tillage, and was used for past
Through this portion, before the trees were set, an ope
which rendered the ground sufficiently dry for planting
black loam common to the prairies of central Illinois,
deal as to richness in different parts. On the highest p
of many years and the continual cropping without fe



Plat of Forest Tree Plantation.

way had left the soil so poor that the common farm
remunerative; while some of the lower parts have a de
overlying tenacious clay. In no case, however, has ma
—probably none had ever been applied—to any portio
which the plantation exists. As far as practicable, adv
of this diversity of soil and location in planting, so as
ments of the several kinds of trees. The tract is on
rods long from north to south. The rows of trees ru
An east and west roadway divides the plantation into t

VARIETIES OF TREES.

The kinds of trees originally selected were such as
special value or importance, but owing to various cau
made has not been completely filled, while a few othe
added. The following species of trees have been pla
are those of Gray's Manual.

Basswood (*Tilia Americana*).
Tree of heaven or ailanthus (*Ailanthus glandulosus*).
White, silver, or soft maple (*Acer dasycarpum*).
Sugar, rock, or hard maple (*Acer saccharinum*).
Box elder or ash leaved maple (*Negundo aceroides*).
Three thorned accacia or honey locust (*Gleditschia triacanth*
Hardy catalpa (*Catalpa speciosa*).
Tender catalpa (*Catalpa bignonioides*).
Green ash (*Fraxinus viridis*).
American or white elm (*Ulmus Americana*).
Osage orange (*Maclura aurantica*).
Butternut or white walnut (*Juglans cinerea*).
Black walnut (*Juglans nigra*).
Shell-bark or shag-bark hickory (*Carya alba*).
Big shell-bark or king nut (*Carya sulcata*).
Bur oak, over cup, or mossy cup (*Quercus macrocarpa*).
Chestnut (*Castanea vesca*).
White willow (*Salix alba*).
White pine (*Pinus strobus*).
Austrian pine (*Pinus Austriaca*).
Scotch pine (*Pinus sylvestris*).
Norway spruce (*Abies excelsa*).
European larch (*Larix Europæa*).
Red cedar (*Juniperus Virginiana*).

METHOD OF PLANTING.

Most of the trees were purchased as seedlings,
old, of various nurserymen, and were placed in the nu
years. The larch were planted directly in the fore
old, and the first chestnuts at two years. The catalp
walnut and bur oak were grown in nursery from seed
from cuttings, while the box elder, chestnut second pl
hickories were planted as seed directly in the forest.
were also planted white oak and pecans, both of
former mainly from the depredations of rabbits and
eating the acorns, the latter by being plowed up by
These have not been replanted. The ailanthus, hone
were transferred from the nursery when about six

ome apple were planted when four or five years from the root- All of the early planting was done in rows four feet apart, h the exception of Scotch, Austrian and white pine, two feet in v. At this time it was strongly argued that the trees would more upright growth if planted very close, and that the trim- rom time to time would be a source of profit. The later plant- owever, including the hardy catalpa, linden, ailanthus, honey ak, and the transplanted hickory, were made in rows eight feet nd with the trees usually four feet apart. The method of plant- all small trees was as follows:

e ground being put in good condition by plowing, harrowing, use of a plank "clod-crusher," a line was stretched the length of osed row, when by walking upon the line a straight mark was ufficiently distinct for the purpose, after the line was re- Two men went together, one with a spade or shovel, the other armful or basketful of seedling trees. Guided by the mark ner raised a shovelful of earth, the latter put into position a ee; the earth held upon the shovel for the purpose was now on the roots, and was tramped down by the man carrying the n this expeditious way the work was done well, and at compar- ttle cost. The planting of the larger trees was neccessarily at- ith much more labor, in excavating a sufficiently large and deep digging and distributing the trees, and in more carefully filling ne roots, while the result with the small stock ordinarily proved sfactory.

seeds of the box elder, oaks, chestnut, and hickories mentioned ere planted in the autumn as soon as gathered; otherwise the was all done in the spring, and as early as possible. As stated, nuts and acorns were destroyed by rabbits and mice; otherwise lanted seeds did excellently well.

CULTIVATION, TRIMMING, AND THINNING.

young trees were cultivated during several summers, usually , just as corn is worked. While the trees were small enough, corn cultivators were used, after which one-horse double- ows. For the first two seasons the rows were also hoed out about n year. Some of the later plantings were not so well cultivated, cient indications of the fact in the less satisfactory results.

oon as the trees shaded the ground, so as to keep down an in- owth of weeds, cultivation was discontinued; after this very nse was involved in the management of the plantation.

the year 1888 there was but little trimming except such as al- nes naturally to thickly grown trees. The branches of all trees soon decay and fall off, and this has given most of the clean trunks ranging from ten to thirty feet. In most of the ine-like trees the dead branches, being full of resin, remain for

a long time, and, as the tree grows around them, they make loose
in the timber.

In the winter of 1888-9, the white, Austrian, and Scotc
trees were trimmed up to a height of about ten feet, though
the dead wood was taken off. The branches of the white pi
dead now to a height of twenty to twenty-five feet, in some cases
The Scotch and Austrian pine branches have not died so high. I
February of the present year the Norway spruce and Europea
have been trimmed; the spruce to the height of about eight feet a
larch to ten or more. The spruce were trimmed as high as
branches were dead; but the larch have but few live branches
height of twenty feet or more is reached.

From time to time the rows were thinned so that the rem
trees stood four to six or eight feet apart, and after about seven
alternate rows were cut out from the ash, Norway spruce, larch,
nut, black waluut, soft maple, osage orange, tender catalpa, an
The remaining rows were further thinned, in some cases as th
were required to be set out on the University grounds, or for use
farm, as posts, etc.; or in the case of the pines, as the trees died.
of the trees have been trimmed up—the lower branches being cu
so as to leave a clean trunk several feet high: but by far the
number have been left to trim themselves.

MISTAKES IN VARIETIES.

In the spring of 1869 there were purchased 3,000 seedlings of
ash, and special pains was taken by the committee to secure
white ash. The search for seedlings of the latter caused a delay
year, when 20,000 seedlings, believed to be of this species (*Fr*
Americana) were secured.

It certainly requires the knowledge and acuteness of an ex
identify this species in the seedling state; though the seeds them
and the matured trees are quite readily recognized. The second
seedlings was green ash, though named in the reports for severa
as white ash. It may be well to state also that an attempt follo
get genuine white ash seed; an order was made on one of the be
serymen in the country for a sufficient amount of seed to furn
required seedlings. This seed upon arrival was pronounced gre
again, but the dealer being confident to the contrary, some of
planted and green ash seedlings appeared. Once more true wh
seed was gathered, but for some reason, probably because allowed
come too dry, only a small proportion germinated. No white ash
been planted in the forest. The mistake here made is a very co
one in the country generally, and is productive, as in this case, of
consequences. It is the more to be regretted because of the easy
fication of the seed of the several species of ash; no nurseryma
blunder in planting.

a similar way 10,000 seedlings of "black" sugar maple (*Acer* *ı*) were purchased of one nurseryman and a like quantity of " sugar maple (*Acer saccharinum*) of another. Both proved to latter. In this case, however, the distinctions are not so pro-l. Botanists now usually make the former a variety only of the he recognized difference not being deemed sufficient for specific on. Furthermore there is little difference in the trees for timber s.

hen this plantation was commenced, attention had not been called fact that there were two kinds of catalpa, differing from each very important particulars for the purpose of timber-growing as other uses; but two species are now recognized: *C. speciosa*, ly western type, and *C. bignonioides*, the tender or south-east-. Unfortunately the latter was used in our first planting. In-e true western type of this tree, indigenous in the Mississippi though so much better than the eastern variety, was rarely seen ation even in western localities until within the last fifteen years. know that the two kinds are easily distinguishable, and as the sufficiently unlike, no further mistake should be made. As the will show, the two kinds give very different results in the plan-

DIFFERENCES IN VARIETIES.

his connection mention should be made of the difference in of many species of timber trees and of the capital importance ion to these differences in selections for practical arboriculture. e elm (*Ulmus Americana*) varies so much that woodsmen have pecial names for the kinds, of which some are very valuable in uses, while others are worthless. The same may be said of , tulip poplar (*Liriodendron tulipifera*), and cottonwood. Some es are due to soil and situation (a thing also worthy of study), eed of certain trees gives very different stock from that of cer-trees of the same species; sometimes the varieties grow mixed in the same region of country, sometimes the distinctions are in trees geographically separated. The so-called yellow cot-of the Mississippi Valley, the wood of which is readily split ced, is specifically identical with the almost worthless common od (*Populus monilifera*) of our part of the country.

HISTORY OF THE PLANTATION.

further contribution to the history of the plantation, extracts e of the annual reports are here appended, together with tables om the same. It is interesting to note the estimation placed results at the times reported:

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FOREST RECORD FOR 1871.

Name.	No. acres.	No. of trees.	Age when planted, or height.	Cost of trees.	Cost of planting.	Cost of cultivation.	Distance planted.	Per cent living.	Av'ge growth in feet.
Ash, green......	¼	1,360	3 yrs.	$27.20	$6.95	$6.19	2x4	98	.5
Ash, white......	2¾	14,974	2	149.74	35.63	4.79	2x4	95	.5
Catalpa.........	¼	1,361	2	21.77	4.17	2.53	2x4	100	1
Chestnut........	¼	1,361	2	30.00	6.79	3.95	2x4	50	.5
Elm, white......	⅛	860	2	4.76	3.95	3.43	2x4	100	1
Larch, European	2	10,890	1	98.01	21.20	8.50	2x4	25	.5
Maple, white....	⅛	680	3	8.16	6.17	3 89	2x4	98	1
Osage orange....	¼	1,361	2	5.44	4.78	1.30	2x4	98	2
Pine, Austrian ..	¼	680	9to12in	30.00	4.40	2 94	4x4	2	......
Pine, Scotch....	¼	680	1 to 2 ft	30.00	4.25	3.04	4x4	2	......
Walnut, white...	¼	1,361	2 yrs.	20.40	3.43	.85	2x4	99	.5
Willow, white...	¼	1,361	1	8.00	4.67	1.42	2x4	98	2
Totals......	7	36,749	......	$433.48	$106.59	$42.83	....	....	......

All the above trees looked very well the first part of the season, but dur
latter part the white grub (the larvæ of the May beetle) almost destroyed some
varieties. They worked mostly on the European larch and white ash, i
instances girdling the roots entirely, from one and a half inches below the s
several inches down ; and owing to the season being so dry, the trees could not
the injury. White ash two feet high were girdled in the same manner. In t
of the Austrian and Scotch pines we attribute losing so many mostly to the c
of the season. The Scotch pine were never transplanted before, which we thi
one cause of so many dying. Chestnuts were injured somewhat by the grub.'

FOREST RECORD FOR 1872.

Names.	When planted.	No. trees.	Age when planted, or height.	Cost trees.	Cost of planting.	Cost of cultivation.	Distance planted.	Per cent living.	Average growth.	
Ash, green...	1871	......	....	....	......	$2.52	2x4	98	2½ ft	
Ash, white...	"	......	....	....	......	18.52	2x4	93	3 ft.	
Catalpa......	"	......	....	....	......	5.12	2x4	100	4 ft.	
Chestnut.....	"	......	....	....	......	.75	2x4	4	3 ft.	
Elm, white...	"	......	....	....	......	2.37	2x4	100	3½ ft	
Larch, European......	Re-pl.'72	4.000	1 year..	$30.00	$6.90	30.32	2x4	30	2 ft	
Maple, white.	1871	......	....	....	......	.72	2x4	98	4 ft.	
Osage orange.	"	......	....	....	......	4.97	2x4	98	5½ ft	
Pine, Austrian	Re-pl.'72	1,000	9-12 in.	25.00	6.40	6.82	4x4	30	4 in	
Pine, Scotch.	"	1,000	12-15 in.	20.00	3.70	4.20	4x4	20	4 in.	
Walnut, white	1871	......	....	....	......	5.60	2x4	99	2 ft.	
Willow, white	"	......	....	....	......	5.67	2x4	98	4 ft	
Pine, white ..	1872	2,722	12-15 in.	122.49	9.85	12.00	4x4	30	3 in.	1
Spruce, Norway.......	"	1,360	"	29.94	7.45	10.12	2x4	98	3 in	
		10,083	....	$227.43	$34 30	$109.70	....	....	......	$3

FOREST TREE RECORD FOR 1875 AND 1876.

	1875.						Acres	1876.						
eties.	Height.		Growth.		Diameter	Cost.	......	Height.		Growth.		Diameter.	Cost.	Cost from beginning.
	Ft.	In.	Ft.	In.	In			Ft.	In.	Ft.	In.			
pruce....	2	8	...	8	...	$2.55	½	4	3	1	6	...	......	....
e........	2	8	...	11	...	5 95	1	4	...	2	...	1¼	$1.75	$66.31
pine.....	2	8	.1	2	...	2.55	⅜	4	8	1	6	2	5.75	362.79
ne........	3	8	1	2	...	2.55	⅜	5	...	1	8	2	1.80	99.76
....	11	10	3	2	1⅗	6 50	2⅞	15	8	3	4	1⅗	1.80	77.39
....	15	...	2	8	$1\frac{9}{10}$	00.00	⅜	17	6	3	...	$1\frac{9}{10}$	5 40	253.46
....	12	...	2	6	2	1.15	¼	16	...	4	...	2¼	.80	46 69
elm......	12	...	3	...	2	.50	⅛	13	6	2	...	2	.80	39.09
larch....	8	...	3	4	1⅖	3.50	1⅛	10	...	3	4	1¾	.50	18.10
nge.......	10	6	3	...	1¼	1.25	¼	13	6	4	...	1½	21.80	246.24
....	8	6	3	...	...	1.05	½	10	6	1	...	1½	1.25	21.96
nut.......	9	2	2	9	1¾	1.05	⅜	12	...	2	6	2	5.50	43.06
ow.......	12	7	3	7	1⅗	3.50	⅜	20	...	6	...	2	10.60	18.14
e.........	17	8	1	9	2⅓	.55	¼	21	...	4	6	2¾	6.20	38.16
le........	3	...	...	7	...	4 25	½	...	...	...	...	...	.45	25.42
all dead).		...	...	...	...	......	...	...	...	...	...	...	3.75	40.86
few trees)	15	7	3	6	3⅜	......	...	...	...	...	...	...	......	41.59
ltivating)	...	...	...	...	...	......	⅛	7	6	1	...	¾	25.20	....
													1.75	26.95
e season.	...	...	...	...	...	$36.93	...	...	...	...	...	...		
													$95.10	
beginning	...	...	...	...	...	......	...	...	...	...	...	...	......	$1466.97

oregoing table shows the average height and size of the trees in this plan-
growth during the summers of 1875 and 1876, and the cost of cultivation,
with the total cost of each kind and the whole plantation from the com-
t. With the exception of the chestnut, all the kinds planted are now rep-
y nearly their full numbers except as removed by thinning, and all are in
vigorous condition. In 1875 a peculiar blight affected the young leaves
s of the sugar maple, but its cause was noi ascertained. It has not ap-
is year, and the trees have recovered. A fungus leaf parasite has made its
e upon the silver leaf maple, forming black shining patches or scabs some-
ch across and often several of them upon a leaf. It does not appear to be
uctive, but evidently reduces the thriftiness of the tree. The disease is by
new elsewhere, being widely disseminated east and west, but not found,
owledge, in this vicinity before. No remedy is known to me except the all
cticable one of gathering the fallen leaves and burning. From the nature
rasite, this must be a specific where it is possible to make use of it. The
name of the fungus is *Rhytisma acerinum*, Fr. The plantation has been
y free from insect depredations. Several leaf eating caterpillars have
on the elms and walnuts, but not so as to do serious damage. The larva
rfly (*Grapta interrogationis*) has defoliated very injuriously the elm trees
gly, as along streets and on the ornamental grounds, and a sphinx larva in
r the ash; but upon trees in masses they do not appear to work much.

nly addition made since the last report is a quarter of an acre of apple,
ur by four feet. I recommend the addition of box elder and honey locust,
to be grown from seed, which can be obtained at little or no cost. The
ents of a few box elder are given in the table for 1875. They were planted
with the white ash and were then of the same age and size of the latter;
date given the average height of the box elder was 15 ft. 7 in. against 11 ft.
he ash, and the diameter of trunk one foot from the ground, 3⅜ to 1⅗ in.
e showing of the table, the willow is now making the most rapid growth,
ined in average height 6 ft. in 1876. Next comes in order the soft maple

(*Acer dasycarpum*), 4 ft. 6 in.; the catalpa and osage orange, each 4 ft., and the white ash and European larch each 3 ft. 4 in. The two first do not furnish very valuable timber, while that of the four following are very useful. From the most reliable information, we know that the wood of both the osage and the catalpa is almost proof against decay—the dead logs in their native places lie for ages upon the damp ground, hard and sound, while generations of human beings come and go A log of catalpa certainly known to have lain upon the earth in the wet woods of Pulaski county, Ill., during the whole century of our republic, was sawed into boards, and one of them, perfectly sound and receiving a high polish, helped form the collection sent by this University to the Centennial; a piece cut from the plantation nearly four inches in diameter, also went with the collection. This was from seed sown in 1869. The osage orange wood, perhaps, is still more valuable, and the woods of the ash and of the larch are highly esteemed. Upon very extended inquiry during the last winter, in connection with the Centennial wood collection, it was found that the price of wood as fuel had not increased during the last ten years in our state, and that in more than half of the timbered regions the growth was estimated to be fully equal to the destruction. With our immense supplies of coal, it is doubtful if wood can, for many years to come, be profitably grown for fuel; but the finer and better varieties of trees, such as are named above, may yield a handsome profit, while natural forests are burned to clear the ground.

The Coniferæ, as indicated by the figures, are growing rapidly—the white pine being first for the last year; the Scotch and Austrian, for the year before. The growth of these trees should not be compared with that of the deciduous ones, because of the natural slowness of their growth when young. In after years they will overtake their present rivals. The proportionately great expense of the larch, walnut, and butternut for 1876 is due to extra work, pruning and transplanting.

FOREST RECORD FOR 1886.

	Acres.	Distance planted, ft.	When planted.	Age in years, or height.	Average height, ft.	Average diameter, in.	Condition.	Cost of trees.	Cost of planting.	Cultivation, etc.	Total cost.	Receipts.
Ailanthus	⅔	4x8	1881	2	18	3⅓	×	$10.40	....	....	......	...
Apple	[illegible]	4x4	1876-7	4 to 5	18	3⅓	××	50.00	$25.20	$15.00	$90.20	.
Ash, green	3	2x4	1871?	3	40	6	××	76.94	42.58	190.63	310.15	[illegible]
Black walnut	¼	2x4	1873	4	37	8	×××	24.00	8.50	21.14	53.64	..
Box elder	⅛	2x4	1877	Seed	31	5	×××	2.00	....	11.00	13.00	[illegible]
Butternut	¼	2x4	1871	2	30	5¼	×	20.40	3.43	24.23	48.06	...
Catalpa, hardy	⅛	4x8	1881	2	17½	4¼	×××	2.00	5.50	6.50	14.00	[illegible]
Catalpa, tender	¼	2x4	1871	2	28	6½	×	21.77	4.17	43.37	69.31	[illegible]
Cedar, red	.	....	1871	2 to 3 ft.	....	....	××	....	....	....	......	....
Chestnut	¼	2x4	1871	2	....	....	......	30.00	6.79	14.65	57.44	...
Elm, American	⅛	2x4	1871	2	29	5	××	4.76	3.95	10.39	19.10	[illegible]
Hickory, small nut	⅜	2x8	1880	Seed	2-4	...	××	3.50	....	6.00	9.50	....
Hickory, large nut	⅜	2x8	1880	Seed	2-4	....	××	4.50	....	9.00	13.50	..
Honey locust	¼	4x8	1882	2	13	2	××	10.00	6.40	5.00	21.40	...
Larch { on high land { on low land	2	2x4	1871	1	34	8	× ×××	98.00	21.20	189.44	308.64	[illegible]
Linden	¼	4x8	1881	6	17	2½	××	10.00	6.40	5.60	20.00	[illegible]
Maple, hard	2/8	2x4	1873	3 to 7	22	3	×××	20.00	10.60	20.26	50.86	[illegible]
Maple, soft	⅛	2x4	1871	3	44	7¼	××	8.16	6.17	11.09	25.42	..
Oak, bur	¼	4x8	1885	4	2 3	....	××	15.00	6.00	2.00	23.00	...
Osage orange	¼	2x4	1871	2	23	4¼	××	5.44	4.78	14.14	24.34	[illegible]
Pine, Austrian	¼	4x4	1872	9-12 in	27	6½	××	30.00	4.40	69.36	103.76	...
Pine, Scotch	¼	4x4	1872	1-2 ft.	29	7¼	×××	30.00	4.25	48.14	82.39	[illegible]
Pine, white	1	4x4	1872	12-15 in	25	5½	×××	122.49	9.85	250.45	382.69	..
Spruce, Norway	¼	2x4	1872	12-15 in	25	5	×××	29.94	7.45	34.92	72.31	[illegible]
Willow, white	¼	2x4	1871	1	59	8¼	×××	8.00	4.57	27.49	40.16	...
Totals	..	....	.....	....	....	....	. ....	$637.30	$192.28	$1029.79	$1846.87	[illegible]

In explanation of the above table it may be said that the distance apart is the original spacing of the trees. Most kinds have been thinned. The dimensions of the trees are those taken in October, 1886. The present condition of healthfulness and thriftiness is indicated in the column by crosses. Here one cross stands for poor order, two, fair only, and three, in excellent condition and promising in appearance. In the case of the larch, a double indication is required on account of the difference in the ntation on the low and high ground. In the columns of cost, the exact items are down when known, otherwise approximate estimates are made. When the young s were purchased, as was the case with all those planted in 1871 and 1872, except tender catalpa and butternut, the exact figure is recorded, but when the seedlings e grown on the University grounds the account of cost was kept with the whole forest-nursery — not with the separate rows or blocks of different species. So in the cost ultivation, the amounts named were often obtained by dividing the full amount rding to the areas occupied by the kinds. In the column of receipts the amounts approximate sums. When trees or trimmings were used for the University a ite credit was not usually made, and was not carried to the special kind of tree. items of cost of the trees and the receipts so far are not regarded as of any rtance in the experiment, because they cannot be made use of in arranging for her plantation, on account of the great variation of prices and circumstances. As dy said, the small receipts were almost wholly for trees to transplant. Another or place there might not be such a demand. Certainly no one should t upon such sales as one of the legitimate and regular items of income from est plantation. Only in so much as the latter partakes of the nature of a nurerys he sale of living trees be considered appropriate to it.

Vhen not done directly by the University, the trees were cut away in thinning en who took the poles for the work. In this way, while no credit is given ne trees, the removal of those in alternate rows, as described, has not cost ing which should be charged against the plantation.

n most instances these trees removed were used for firewood; sometimes, for s or poles.

HISTORY OF THE SEVERAL VARIETIES.

AILANTHUS (*Ailanthus glandulosus*). These trees were grown seed in nursery, and when two years old transferred to the forest, 81. They made a very rapid growth from the beginning, probably ssing all other kinds in this respect. In four years' time a height out sixteen feet was attained, with proportional diameter of stem. luring the winter of 1884–5 they were killed to the ground. One specimen on the University lawn, which had stood unscathed the s of fourteen winters, also perished. The following summer pro-us shoots were sent up from the old stocks, some of them stretching ring the single season to eight or ten feet in height. The new growth een suffered to care for itself, and the block therefore looks rough neven. The trees are very irregular in size. Many of those that not killed entirely to the ground are now 35 to 40 ft. in t and one foot in diameter of trunk one foot from the ground. ts have come up thickly from the roots so that there are trees of zes from 2 or 3 ft. up to 40 ft. in height. They have arly taken complete possession of the ground where they were ed that no other woody plant except the black raspberry has been o get a start among them. This habit of root sprouting is one of eatest drawbacks as an ornamental tree. In the forest plantation e the ground has not been fully occupied by other trees the ailan- has spread in this way as much as 50 ft. The more the ts are cut off the thicker they come up again, but on land that is occupied by other trees they seldom sprout.

Aside from the liability to destruction by frost during specially winters, it is questionable whether this species has any value for r. It certainly does grow wonderfully fast, at least when young, and that, too, on poor soil; but the wood has little value. It is coarse grained with a rather pleasing color, does not take much polish, but when well prepared it might make an agreeable variety for use in some kinds of furniture.

APPLE TREES (*Pyrus malus*). In 1876-77 there was an overstock in the nursery of Perry russet and Stark apple trees, root-grafted in 1872. These trees were in excellent condition, but as no market was found for them it was decided to try some as timber trees. One-fourth of an acre was planted in the spring of 1876 with trees four years old, and a similar area, or a little more, the following season. All had been "cut" with a tree digger in the fall of 1875, but not moved from their place until transferred to the forest. The first were planted 4 ft. by 8 ft. apart, and occupy a block on the west side of the plantation, where they are exposed to the sweep of the prevailing winds of which they clearly show the effects. The outer rows are bent over to the eastward very conspicuously, and the average height is less than would otherwise have been the case. In this block the average measurements in 1886 were: height, 17 ft. 9 in., circumference of trunk, 10 4-5 in. In the second block, planted 4 by 4 ft. apart, well sheltered on all sides, the height was 22 ft., and the trunk same size as above. Four or five years after planting the whole ground became shaded by these trees, after which no undergrowth of any kind, except mosses and other low plants, existed. The trees have grown much more erect than they commonly do in the orchards, but the main stem soon becomes divided into many branches, even when closely crowded. Little can be said in favor of the tree for timber. The wood, if of good size and straight grained, is very valuable for purposes where fineness and closeness of grain, together with hardness and susceptibility of polish, are requisites.

The block of Stark, surrounded on three sides by larger growing trees, is 32 feet in height and ten of them 4 to 5 inches in diameter. Many of them are dead or dying, though apparently not from blight. The trees in the two rows next the white pines are nearly all dead, and the influence of the pines is seen on the third and fourth rows to some extent. The block of Perry russets, fully exposed on the west, seems to have given a strong argument against protection. There are only four rows of these trees, eight feet apart. East of the apple are two rows of basswood that were set five years later and next east of the basswood are black walnuts. The apple trees in the west row are all alive and nearly all in good health. The second row from the west is nearly all alive. More than two-thirds of the trees in the third have died, while in the east row there are only six trees left alive. These trees did not all die at once but have been going year after year for the past eight years.

GREEN ASH, (*Fraxinus viridis*). As has been stated the greater portion of the ash planted was supposed to be white ash (*Fraxinus* *cana.*) Nearly three acres were planted 2 by 4 ft. in one block, e-fourth of an acre in another block, on, however, similar ground. ›ved to be green ash. Both lots were planted in the spring of ıd in both cases nearly all the trees grew thriftily from the be- ;, gaining 6 in. the first year. Those in the three-acre lot were two- l seedlings, the others, three years old; both were from nursery Like the larch and chestnut, the roots of these young trees were rably gnawed by white grubs the first season, and the losses may ›st wholly attributed to this cause.

ıe ground upon which the ash are growing is rather low and For any agricultural crop, tile draining would materially improve ıe black, vegetable loam is quite deep, underlaid with tenacious clay. An open ditch through the lowest portion carries a stream r during the first half of most summers.

ltivation by plow and hoes was thorough during the first four and afterwards the plow was run occasionally between the rows. the trees became large enough for planting in shelter belts, etc., a large number were taken here and there from the rows, ıg in 1875 and continuing ten years. In 1876 and afterward ows were dug for these purposes, and in 1878 the remaining : rows were cut down. The growth of the trees has been ex- y irregular. Those that get the first start gain more and more upon aded companions, so that there may often be found two trees of : age standing side by side, yet one ten to twenty times as large ther. Evidently this ash does not succeed well in the shade, the latter is not dense enough to keep down the conspicuous owth of weeds and many kinds of shrubs. An occasional box parently grows as vigorous surrounded by thickly set ash as he latter were not present. In natural forests the green ash is specially on the banks of streams, while the white ash more ly grows among other trees on rich bottom land. Does the perish in the shade and succeed in the opening made by er. In this connection it ought to be noted that sprouts undantly sent up from the low stumps left in thinning and that l make a slender but considerable growth. Some of these are ger than certain specimens of the original planting.

ere is more undergrowth among the ash than appears under any es. It is indeed very interesting to observe the great number oby and other growths which normally belong to woods. It remembered that the land was originally prairie and had been d in farm crops for thirty or more years, yet one now finds here umbers of raspberry and blackberry bushes, cherry, Virginia poison ivy, dogwood, elder, grape, red and black haws, red esides beggar lice, "stick-tights," and various forest dwelling ınd grasses; in smaller numbers laurel oak, scarlet oak, white kory, hazelnut, sassafras, mulberry, hackberry, honey-suckle,

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gooseberry, currant, cat briar, and a few others. These introduced woody plants now considerably outnumber the ash trees.

They evidently have been brought in by birds, for it will be noticed that the kinds named bear berries or other fruits commonly eaten by birds, or are furnished with appendages by which the seeds or pods adhere to feathers, etc. Great numbers of birds do resort to the plantation for roosting and shelter. The nearest natural wood is about three miles distant.

It is difficult to state the average size of these trees, on account of the extreme variation. In 1886 the better specimens were 5 to 7 in. in diameter and 40 ft. in height, a few running over that. At present the range of diameters is from 1 in. up to 11 in., but the small ones can of course never make anything of value. The average diameter is near 6 in. while the better specimens such as were given seven years ago are from 8 to 9 in. in diameter, and 45 to 48 ft. high. The trunks are tall, slender, nearly free from living branches for half or more of their height and in the main are straight. What are not straight now would become so before reaching a size suitable for making into lumber. The growth of the tree is always greatest on the inside of a crooked place, and unless the crook has been too great, the tree shows nothing of it by the time it is full grown. Among the specimens from 1 to 3 in. in diameter, at least half are dead entirely, or dead at the top. As the trees stand at present each one has a space of about seven feet square, though the distribution is very irregular.

The actual sizes of the trees on the large plat are as follows: 63 are 1 in. in diameter; 653, 2 in.; 657, 3 in.; 516, 4 in.; 392, 5 in.; 257, 6 in.; 131, 7 in.; 57, 8 in.; 9, 9 in.; 1, 10 in.; 1, 11 in.

On the small plat the trees are of the following sizes: 3 are 1 in. in diameter; 1:9, 2 in.; 112, 3 in.; 77, 4 in.; 31, 5 in.; 24, 6 in.; 5, 7 in.; 4, 8 in.; 1, 9 in.

At the end of the first year after planting, the three-year-old trees cost at the rate of $160 per acre, while the plantation of two-year-old seedlings cost $85—the difference coming from the greater original cost of the three-year-old-seedlings and the greater labor in handling them. It requires at least twice the labor properly to plant a three-year-old tree of this kind than it does one a year younger. At the present time no difference can be discerned in the size of the trees.

BLACK WALNUT (*Juglans nigra*). The nuts were planted in the spring of 1869, in nursery. There is, by some inadvertence, a break in the records concerning the transplanting of these trees, and the facts connected therewith, have not been remembered. They were not transferred until after 1872, but in the autumn of 1875 they were over 9 ft. in height, and had been growing vigorously in their permanent place. When transplanted—probably in the spring of 1873—quite a number died, as might be expected of this variety at four years of age. They were put into rows 4 ft. apart, 2 ft. in the row, but the following vere distributed so as to make, as nearly as practicable, the e in the row uniformly four feet. They occupy three-eighths cre on soil of good quality for corn.

the autumn of 1876 these trees were 12 ft. high and ex- ly healthy and vigorous in appearance. They were fairly well ed, and the lower branches were trimmed off so as to leave a trunk 4 or 5 ft. high, but since 1878 no labor has been expended em. In 1886 the best of the trees were 37 ft. high and 25½ in. mference of the trunk. They were making a rapid growth, with , clean stems and fairly good amount of foliage. The latter, r, is never so abundant as in several other species. The better ns are now 8 to 9 in. in diameter, 40 to 45 ft. in height, and most have fairly straight trunks for half to two-thirds their height. all trees (those running from 2 to 4 in) are out-topped and are ng to look bushy or dead in the top. There are now standing on of an acre, 176 trees. That does not allow quite ten feet y for a tree. It cannot be expected that trees standing so close e the best development long and these will soon need further .

sizes of the trees on the plat are as follows: 15 are 2 ins. ter; 8, 3 in.; 17, 4 in.; 27, 5 in.; 26, 6 in.; 39, 7 in.; 26, 8 in.; ; 3, 10 in.

ere is considerable undergrowth, consisting for the most part of ving weeds and grasses, but also various shrubs and climbing

ile these trees make a rapid growth, and ultimately reach a e, it can hardly be claimed for them that they stand at the head st for timber purposes. The wood of old, well grown trees is gly valuable. But it is only the wood of large trunks that com- igh prices. That of young trees is not specially prized for . From seventy-five to a hundred years is not too great an for the time required for the development of this tree into a of high commercial value, and who can count upon the relative kinds of woods a century hence? Then these large trees de- large area in which to reach the majestic proportions of com- prominence. As shelter belts we have better trees, and for fur- the miscellaneous purposes of farm supply other kinds will be cted. It is not, however, wished to cast any discredit upon this ee—the most prominent representative abroad of our North n forests. Its lofty, feathery crown is worthily worn, and, no judiciously mixed planting for timber, this regal tree should place.

ELDER (*Negundo aceroides*). The seed was planted in the 1876 thickly in rows 4 ft. apart, where the trees were to The next spring the rows were thinned with the hoe, so as to e seedlings at first one foot apart. Two years later every other

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tree was removed, usually for transplanting. Alternate rows were dug for planting a part at a time as the trees were wanted from 1881 to 1884. During this time the remaining rows were also thinned to about four feet between trees. The area is about one-fourth of an acre in a long strip adjoining the wet portion planted with larch. A part of the ground is very wet in the first part of the season; one end is moderately well drained. The trees have done excellently well throughout, and the block has cost less in proportion to size or number of trees than any other. The first year cultivation was thoroughly kept up during the season, and the second year double shovel plows were run in the rows three or four times. After this the shade was sufficient to keep down the weeds, and from that time to the present the ground has been perfectly free from any kind of undergrowth.

The trees are tall and slender, with clean trunks high above one's head, and they are remarkably uniform in size for such close growth. While the trees appear straight to the casual observer it is almost impossible to find one that is not crooked. The crooks are not short but take the form of long curves. The size (ten years from seed) of the larger specimens, was 30 to 31 ft. in height and 16½ in. in circumference. The larger specimens are now 40 to 45 ft. in height and 6 to 8 in. in diameter at one foot from the ground. This plantation is in appearance very excellent, and, were the wood worth anything, most valuable results might be anticipated. The record is worth consulting in regard to groves and belts for shelter. The tree seems to accommodate itself easily to its place. There is a space of about a rod wide between these trees and the plat of larch, and the outside rows (and especially the outside one) produce much the larger trees, and the trees lean very decidedly toward the open space. As the trees are now standing they have a space of less than 5 ft. square each.

The sizes of the trees on the plat are as follows: Forty-nine are 1 in. in diameter; 93, 2 in.; 85, 3 in.; 105, 4 in.; 72, 5 in.; 50, 6 in.; 20, 7 in.; 13, 8 in.; 2, 9 in.

BUTTERNUT (*Juglans cinerea*). The nuts were planted in nursery rows early in the spring of 1869, and when the seedlings were transplanted two years afterward they were 15 to 20 in. high. Ninety-nine per cent survived and made an average growth the first season of 6 in. At the end of the second year (four years from seed) the average height was 2 ft. In the autumn of 1876 the trees were 10 ft. 6 in. in height. In 1886 the better trees were 30 ft. in height, with a circumference of trunk of 17¼ in. At present (1893) the better trees are from 6 to 8 in. in diameter and from 38 to 42 ft. high. Most of them carry a straight trunk as much as three-fourths of their height. These trees for the first five years received good cultivation and were twice trimmed, taking off the lower branches, which were very heavy and spreading. No pruning has been done among them since. The lower branches have been gradually smothered out and have rotted and dropped off until now w of the trees have any under twenty feet in height. Most of es that are given in the table as 2 and 3 in. in diameter are either t the top or are otherwise in very poor condition. As the trees t present they occupy only a little more than 7 ft. square each. ie sizes of the trees on the plat are as follows: 37 are 2 in. in r; 151, 3 in.; 168, 4 in.; 118, 5 in.; 46, 6 in.; 21, 7 in.; 6, 8 in.; .

ie soil is rather wet yet not too much so for corn growing, ex- specially wet seasons. Probably the trees would have done bet- rier land. As it is, no kind except the larch on wet land has o much disease. But there is nothing in common with these to the manner of destruction. With the larch the whole tree l a sickly appearance, growth became slow, the foilage thin, and nes) abnormally produced. Finally the half-dry branches failed nd to the stimulating influences of spring time and death occurred. case of the butternut the difficulty apparently began with the nd seemed to be due to frost. The living bark was forcibly d in patches from the wood, or not unfrequently cracks occurred bark and wood toward the center of the trunk. In some cases, r, patches of bark on the trunk or larger limbs died without ap- eparation, and various fungi afterward grew out of the decaying Indeed, the trees seem to suffer just as orchard apple trees have oughout the Northwest during the last decade. Trees of this re not usually healthy or long lived in the native woods of the It is not common that good saw-logs can be had from them nt of the irregular growth or unsoundness of parts of the trunk. er woods on richer but better drained land the trees appear in etter condition and not unfrequently free from any apparent

e widest spaces caused by the death of trees as described were transplanting from the thicker rows, but the distribution is still and not seldom the vacant spaces are now too wide. Although le has never been very dense, there is not much undergrowth, veeds. Altogether the prospect is not favorable for this tree in plantations.

TALPA (*Catalpa bignonioides*). This is the southern or eastern sometimes called the tender catalpa. The seed from which were grown was gathered by Hon. W. C. Flagg, from trees by himself upon his farm at Moro, Illinois. At this time nd for several years afterward the distinctions which are now to exist between trees of this genus had not been made out. astern nurserymen supplied the western parts of the country ost of the nursery-grown trees, and since this tree produces ix to ten years an abundance of seed, it need not be surprising n in the areas in which the hardy catalpa naturally existed the r planting were mostly gathered from cultivated trees, and so

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from the eastern or tender kind. This was the case with Mr. Flagg and also with the University. The catalpas planted in the early years were also of the tender kind.

This seed was planted in the spring of 1869 and the seedlings were transplanted 2 by 4 ft. apart in 1871. Having a crooked and much branched top, this was cut off near the ground in the spring of 1872, and a single shoot allowed to grow from each. This latter often attained 6 ft. or more in height the first season — a straight, clean, unbranched stem. In five years the average height was 16 ft. and the average diameter of the stem 2¼ in. The height of the better specimens in 1886 was 28 ft. 3 in., and the circumference of trunk 20 to 21 in. The better specimens at the present time are 7 to 9 in. in diameter and 35 to 38 ft. in height. Very few of them have straight trunks as much as ten feet in length, and most of them are so crooked that it is hard to get good 7 ft. posts without considerable waste. Taking crooked and straight, together with what might be split, the trees would make an average of about four posts each. But few of the trees are perfectly sound. By actual count 132 of the 263 trees give evidence of being unsound, and there are no doubt other unsound ones that do not yet show decay externally. None of the trees have escaped injury by frost. Usually the wood of certain annual growths of the trunk is dead and decaying while many of the limbs, not unfrequently the terminal portion of the "leader," have been killed, making the subsequent growth irregular and crooked. When the trees were 2½ in. in diameter every other one was removed and used as grape stakes. They were cut in the spring and immediately driven into the ground by the side of a vine. Notwithstanding the known durability of this wood in the earth, these stakes rotted so badly that many had to be replaced after the first year, while none lasted longer than three to four years. But it must be remembered that the wood was in part already injured by winter killing and that the stakes were used while green. The sap wood soon decays in the earth under any circumstances, and since in poles of this size there is a large proportion of sap, it is to be expected that such stakes will soon become more or less reduced by rot. But they last much longer if seasoned before setting in the ground and especially if cut in late spring time when the bark peels readily.

Alternate rows were removed six years after planting. As the trees now stand each one occupies an average of a little more than 6 ft. square. The tops of all are thrifty and continue to make good growth. During the past winter one-fourth of the plat was cut down close to the ground and the trees worked up into posts. It is the intention to allow the trees to sprout and grow again from the stump. The sprouts so growing will probably make straighter trees than the originals.

The numbers and diameters of the trees are as follows: 4 are 2 in. in diameter; 34, 4 in.; 71, 5 in.; 61, 6 in.; 50, 7 in.; 28, 8 in.; 9, 9 in.; 6, 10 in.

ARDY CATALPA (*Catalpa speciosa*). The seeds from which these me were planted in nursery May, 1876. When two years old ng trees were moved to the permanent plantation and set in ft. apart, 4 ft. apart in the rows. From the first these s took an upright growth quite different from those of the variety.

e land is the highest and is accounted the poorest in the planta- It is the same as that occupied by the portion of the European which has succeeded so well. As was the case with the other all the young trees grew — not one died in either case. Not- nding the transplanting a growth 4 ft. in height was made st season. Good cultivation was given the first year, but was done with trees or soil the second season on account of the e of business in other quarters. The third year again the ground pt in good order, after which little attention was given to it.

e trees continued to grow luxuriantly, forming straight trunks, ed with coarse and distant, but symmetrical branches. Not or branch has been noticeably injured by frost. The aver- ight of the better trees in 1886 was 17½ ft., and circum- of trunk a little over 14 in. This was for six years' growth, or rage of about 3 ft. increase in height per year. Quite a num- he trees have been taken out for transplanting, leaving them, so he thinning has gone, 8 ft. apart each way.

e better trees now are 30 to 34 ft. high and 7 to 9 in. in diam- one foot from the ground. Unlike the tender catalpa these e rapidly in size for the first 3 or 4 feet. After that they heir trunks straighter and hold their size better than *C. bignon-* Without a more thorough examination than has been made it be impossible to tell the condition of the timber in these trees; of what appeared to be the best specimens (which were cut for forestry exhibit) were both rotten at the heart from the ground 10 ft. in height. Many of the trees taken from the same lot, years ago, for transplanting soon broke off from one cause or and all were found to be decayed except a thin outer shell.

e ease of propagation, the usual freedom from disease and injury, success in transplanting, the wonderful rapidity of growth, ellent form of the tree and the value of the wood eminently ish this species as valuable for timber plantations. Its home is ch "river bottoms," where the trees attain a height of 80 ft. liameter of trunk of 2 to 3 ft., or equal to that of the white ut on poor soil it is probable that the mature tree will be smaller eral of the oaks and other first class forest trees. From such tion as we have the tree cannot be said to be especially long In the woods they are often found dead and often lying on the Of the proved durability of the wood on or in the ground, ch can hardly be said. Fence posts cut from old logs have

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remained sound in wet ground forty years, and old stockades have been examined after double this length of time and the wood still found free from decay except the slow wasting away of the surface portions. A log lying across a creek forming a foot-bridge was known by one man to have occupied its place for sixty years, and his information was that at least forty years before his time the log was used for the same purpose. This log was in 1875 cut into boards one inch thick, the widest of which were 18 in. of sound wood. The outer edges were more or less decayed and worm-eaten.

The wood is soft and coarse-grained, is easily worked and keeps its shape well even when cut green. For posts, piles and railroad ties, and for some manufacturing purposes it takes high rank, but for fuel and many special uses other kinds are superior.

The sizes of the trees on the plat are as follows: 11 are 2 in. in diameter; 5, 3 in.; 11, 4 in.; 18, 5 in.; 32, 6 in.; 33, 7 in.; 17, 8 in.; 8, 9 in.

All the trees, except those put down as 2 and 3 in. in diameter, are vigorous and making a good growth.

RED CEDAR (*Juniperus Virginiana*). A few trees of this species were planted when about three feet high in the spring of 1871, on rather dry but rich ground. They stand in two rows about ten feet north of blocks of other trees. They have had except for the first year or two but little attention. The transplanting succeeded well; nearly all the trees lived. They have made a very moderate but steady growth, not, however, appearing very luxuriant or vigorous. The stem usually continues through the head with, however, in numerous cases, competing branches. The head itself is bushy, with close and dense foliage. There is nothing of special promise about them as timber trees on our soil, notwithstanding the recognized value of the wood.

There are now standing only 46 trees; the rest have been cut down or dug out for various purposes. They vary in height from 18 to 25 ft. and are from 5 to 7 in. in diameter at one foot from the ground, and decrease rapidly in size. They would undoubtedly be better for closer planting which would compel them to run up more slender and sooner to lose their lower side branches.

CHESTNUT (*Castanea vesca*). This has been a failure. In 1871 1,360 two-year-old seedlings were planted, of which one-half died the first season. But the roots were badly gnawed by the white grub which existed that year in great numbers in the soil, which was kept clear from other vegetation upon which the worms might feed. As the trees were first set 2 by 4 ft. apart, an attempt was made to make the distribution uniform by transplanting, but the growth continued feeble, and all the trees ultimately died. The land was high and dry adjoining that upon which the larch has so abundantly prospered. A few trees, however, which were set in nursery survived, and after becoming well established have grown rapidly and continue healthy.

It having been asserted that these trees succeeded better if grown from seed without transplanting, the experiment was tried by planting, in the area first occupied by them, fresh nuts in the fall of 1879. These were badly destroyed by rats and other vermin, but such as were left grew very satisfactorily the following year. During the first winter rabbits cut off many of the young stems, and some died. Growth continued poor, and the number of trees gradually became less. Those remaining were transplanted into one row, and now this remnant of the lot are bushy, poor looking, shrubby specimens of little promise. On the other hand some trees three or four year old, received from Mr. C. N. Dennis, of Hamilton, Ill., in 1860, and planted in the arboretum, have done remarkably well. They are exceedingly thrifty, finely proportioned, and gaining as fast as the neighboring ash and elms. No explanation is attempted of the difference. The soil in the latter place is richer. The cultivation was altogether better with those first described.

AMERICAN ELM (*Ulmus Americana*). Only one-eighth of an acre is planted with this common white, or American elm. There are four species of elms native to Illinois. The largest and most abundant is the subject of this report. The next largest, and also next in usual numbers, is the red, or slippery elm, well known for its thick and mucilaginous inner bark. The hickory elm, found in special localities only, is a medium or small sized tree, known, as the common name suggests, for its tough wood and the peculiar wing-like expansion of bark along the branchlets. The fourth species is found in the southern part of the state only, and from the growth of bark on the branchlets, surpassing the latter in prominence, is called the winged elm. It is scarcely more than a tall shrub.

Among these it ought not to be difficult to identify the species with which we are now concerned. Yet such are its variations; so different the appearance of trunk, branches, and foliage; so diverse the characteristics of wood; and withal so many the woodman's names, that many hesitate to put all forms and kinds together as one species. Of the specific unity, however, there can be no question. Many of the observed differences are due to the surrounding conditions, as of very wet and of dry soil, of the chemical or physical characteristics of the latter, of the sweep of winds, etc. But there is also great natural variation in the individual trees when grown under conditions as nearly identical as it is possible to get them in a group or along an avenue. It is entirely probable that seed from individual trees of such species reproduces the characteristics of the parent. Plants that have not been changed under cultivation come more nearly true from seed than those that have been changed. There are comparatively few elm trees that are perfect in shape.

The seedlings were two years old when, in 1871, they were placed 2 by 4 feet apart in the plantation. All lived and grew rapidly.

As they became large enough for the purpose, the most of those to be removed for thinning were dug for transplanting. The better trees measured in 1886 a little over 28 ft. in height and 15 in. in circumference of trunk. These at present are 45 to 48 ft. in height and have a diameter of trunk at one foot from the ground of 7 to 9 in. Of those put down in the table below as 1 to 3 in. in diameter, most have a stunted appearance and some of them are nearly dead. The better ones have nearly straight trunks, free from limbs 20 to 25 ft. in height. The shade is dense enough to keep down most of the undergrowth except what grows naturally in the shade. As the trees now stand they have a space of less than 8 ft. square.

The sizes of the trees in the plat are as follows; 2 are 1 in. in diameter; 22, 2 in.; 13, 3 in.; 8, 4 in.; 15, 5 in.; 14, 6 in.; 11, 7 in.; 4, 8 in.; 6, 9 in.; 3, 10 in.; 2, 11 in. This is far less than the same trees measure planted along streets 50 ft. distant from each other. Even some of those transplanted from these very rows are now twice the average size of their thickly set companions. This seems to show that the elm does not bear crowding well, at least by its own kindred. As a timber tree little can be said in its favor, however much we may admire it for ornamental purposes. There are special uses for its fine-grained, interlocked, fibrous wood, but the demand is limited and uncertain.

HICKORIES (*Carya alba and C. sulcata.*) Nuts were collected of these two kinds, known as the small-fruited and the large-fruited shell-barks, in the autumn of 1879, and at once planted in the forest-tree rows. Some of the nuts were destroyed by vermin, but the most of them germinated and grew the following spring, making, however, small progress during the summer. During the first winter, and to some extent, afterward, many of the young trees were cut off by rabbits. These, however, usually sprouted out again from the stump.

The hickory is naturally of slow growth when young, and the trees are on land that is comparatively poor, high, and dry. In the spring of 1883, the rows as planted were thinned out and the trees taken up were planted in rows 8 ft. apart and 4 ft. apart in the row. Considerable care was taken with the young trees both in digging and setting. The tap root was taken up from 16 to 20 in. long and but little loss occurred from moving. The transplanted trees as well as the others were cultivated for two years; since then they have received no attention except to prune off the lower branches in 1890. In 1886, the trees that had not been removed were from 4 to 8 ft. high, twice as tall as those that were reset. At present the trees not transplanted stand 4 ft. apart each way and are all making a good vigorous growth; the better ones are 15 to 18 ft. high and from 2 to 3 in. in diameter.

The better ones of the transplanted trees are 10 to 12 ft. high and comparatively few of them exceed 2 in. in diameter.

The sizes of the trees in the plat are as follows: Hickories not transplanted, 46 under 1 in.; 252, 1 in.; 63, 2 in.; 5, 3 in.; hickories transplanted, 109 under 1 in.; 364, 1 in.; 37, 2 in.

The land, as before stated, is high and dry and the soil is poor. This is one reason for the slow growth, but the ailanthus and hardy catalpa, on the same soil, have shown remarkable vigor. As between the two hickories, the large-fruited one has surpassed the other, though it is more often found on lower land.

HONEY LOCUST (*Gleditschia triacanthos*). Two-year-old seedlings were planted, 4 by 8 ft. apart, in the spring of 1882. At the time of planting the trees were 4 to 5 ft. in height, and were not cut back in any way. In 1886 the better trees were 18 ft. high and 6½ in. in circumference. At present they are 28 to 32 ft. high and 4 to 5 in. in diameter. All of them look very crooked and if they did not straighten up as they grew older they would be a worthless lot; but the trunks and larger branches seem actually to bend in their effort to straighten, so that a branch this year does not occupy the same position absolutely that it did last.

This tree attains lofty dimensions in native woodlands, but is not highly esteemed. The wood is coarse-grained, not tough, but exceedingly hard. It is said that it shrinks less in drying than any other native wood. It is not very durable when subject to moisture. There may be special uses for which the hard and conspicuously grained wood would be highly prized. It is susceptible of a fine polish, and probably could be advantageously used in furniture making and in joinery.

The sizes of the trees on the plat are as follows: 71 are 1 in. in diameter; 164, 2 in.; 95, 3 in.; 31, 4 in.; 11, 5 in.; 4, 6 in.

EUROPEAN LARCH (*Larix Europæa*). One and one-fourth acres were planted; rows four, and trees in rows two feet apart. The land varies much in fertility and in subterranean drainage. One-half of the area is relatively high, and in the soil no water stands within several feet of the surface at any time of the year, at least not for many days at a time. This soil is too poor to grow a fair crop of corn, but would answer satisfactorily for oats. The subsoil is yellow clay, with enough admixture of sand to make drainage fairly good. The northern end of the area reaches down into lower land, where water would run from a tile drain during a large part of the spring and early summer, though it does not stand upon the surface. Sometimes in the spring the wettest portion is so soft that a horse's feet would sink three or four inches in the black and rather mucky soil. The seedlings were one year old when planted in the spring of 1871. During the first year three-fourths of these died, more dying upon the high than upon the low ground. All started well, but the roots were badly damaged by the white grubworm, and the season proved to be very dry; during August the dead or dying numbered more than the thrifty trees. Cultivation was diligently kept up during the summer.

The next spring 4,000 more seedlings were purchased and planted

European Larch on Low Land

in the rows, leaving no spaces of more than four feet. In this way the distribution of the trees was not quite even over the ground, but was sufficiently so to accomplish the object of thick planting. Again the grub-worm did some damage to the roots, but far less than during the preceding season; none was noticed afterwards. Nearly all the trees lived and made a fair growth. Cultivation was kept up during the summers of 1872, 1873, and 1874; but in 1875 the land was so wet during the spring and early summer that it was deemed best not to run the plows. The weeds grew abundantly and made a bad appearance, but they did not seem to injure materially the growth of the trees. At the end of this season, however, it was observed that the trees occupying the wettest portions of the ground looked unhealthy and many were found entirely dead the following spring (1876). Up to this time they had apparently done nearly as well on the low as upon the higher land. Finding that the trees, now five years planted, needed thinning where two feet apart, a considerable number were dug and planted in the vacant spaces. Most of these transplanted trees lived and grew without serious check, but from this time on those on the low ground proved more or less unhealthy. The trees which lived had less than the normal amount of foliage, which was usually yellowish in tint; the branches were slender and wiry, and fruit-cones were abundantly developed. More or less of the trees have died every year until at present, 1893, there are not quite one-fourth as many trees on a given area as on the higher ground. The roots on the low ground run near the surface, with apparently no tap roots. During the spring just past at least ten trees, better than the average in appearance, have been blown down on the low ground, but among the taller trees on the higher ground none have been disturbed by the winds. While there are a considerable number of trees on this lower ground still living, the plantation is anything but attractive or hopeful in appearance. On the higher ground, however, scarcely a tree, except such as have been out-topped, has died or shown any indication of unhealthfulness.

In 1876 the trees in two of the central rows were trimmed by cutting off the lower branches so as to leave a clean trunk 2½ to 3 ft. high. The rest of the trees were left untrimmed, with their branches issuing from very near the ground and spreading so as to interlace with each other. The average height of the trees was at this time 10 ft. These trimmed rows cannot now be picked out, except upon the closest looking for the few remaining dead branches on those not trimmed, and an occasional appearance of the old wounds. But during three succeeding years the growth in height of the trimmed trees was evidently less, and no doubt careful measurements would have shown a similar result for the circumference of the trunks. Unfortunately such measurements were not made. Now the variation in growth in other ways obscures the results, if there are any.

European Larch on High Land

Except in the outer rows there are no living branches under 20 to 30 ft. in height. The dead branches do not rot and drop off readily, being kept from rotting by the large amounts of resin in them, but they are easily broken off. During the winter just past the whole plat has been trimmed to a height of 10 ft., only stopping at that because the man could not reach higher with the tool he was using.

In the winter of 1883-84 a heavy sleet storm broke the leaders out of a few of the trees. While those broken off have made new leaders, they have also started to decay where broken.

During the winter of 1877 and 1878, alternate rows were removed by cutting the trees near the ground. Since the spring of 1889 over 100 of these trees, those below the average size, have been cut down and made into fence posts or grape stakes. The trial has not continued long enough to decide, but the indications are that the larch will not prove specially valuable for such uses.

Since 1880 the ground has been entirely free from weeds, owing to the dense shade of the inwoven branches and the thick carpet of fallen leaves. This plantation on the high ground is a beautiful and encouraging sight. The trees are quite regular in size, symmetrical in growth, tall and straight, with the lower limbs wasted away so that one walks easily under the thick canopy of foilage above, and on the soft and clean matting of the fine leaves below. The height of the better trees in 1886 was 33 ft. 9 in. and the circumference of trunk one foot from the ground 24½ in. At the present time they are 50 to 55 ft. in height and from 7 to 9 in. in diameter at one foot from the ground. There is not much difference in height on account of place in the plantation, but the trees around the outside are usually considerably larger in diameter of trunk.

The outer part of each annual ring becomes very hard when the timber is seasoned, while the rest remains soft. It does not have the appearance of being valuable for lumber except for the coarsest uses, such as framing stuff. No tests have yet been made as to the quality of the wood as grown on the different soils, though there can be little doubt that considerable difference does exist.

Some plantations of the European larch in the state are unthrifty, due, as it appears, to an obscure, or at least not yet determined, disease. The twigs are abnormally slender and the growth poor, the leaves die at any time after appearing, progressively from the outer portions, and prematurely fall. Often new ones are pushed out in little tufts, soon to share the same fate; finally the twigs themselves die. As stated the cause or causes of the disease, if indeed it is a disease, have not been ascertained. But the trouble has not been certainly seen in the University plantation, though indications of a mild form of what seems to be the same exists without damaging results. Early in October—a month before the leaves ought to become discolored and fall—what seems to be another disease has been observed. In this case the leaves assume a sickly yellow hue and gradually drop from the branches, leaving the twigs naked but apparently uninjured. A minute fungus of low type (*Cladosporium*) is found on these fading leaves, even after a long season of fair and dry weather, but it cannot be said that the low parasite is the cause of the trouble, from which the tree appears to suffer but little. Red spiders (mites) sometimes become destructive to the foliage of the larch, as they do, in warm, dry weather, to the leaves of many other trees. (See 14th report Illinois State Entomologist [1884], page 117.)

This larch finds a congenial home in high mountainous regions and is especially valuable as a timber tree in the rough, rocky lands of Scotland. It is on trial now for the prairie regions of our country. While the facts now known of it in these situations are not by any means all favorable, the University plantation on dry ground is certainly in most excellent condition, twenty-two years after planting, and the experiment appears to be eminently interesting and instructive as well as hopeful for practically valuable results in timber growing.

BASSWOOD OR LINDEN (*Tilia Americana.*) The seedlings were collected in the forest in the spring of 1876. It was not the intention at first to put them into the plantation, hence they were allowed to grow longer in nursery than should have been done for this purpose. As it was, however, the smallest trees had been left in the nursery rows, and these were transferred to the forest in 1881, placed 4 by 8 ft. apart.

In 1886, the better trees were 17 to 18 ft., and 8½ in. in circumference of trunk. Now, 1893, they are 26 to 28 ft. in height and 4 to 5 in. in diameter. A considerable proportion of the trees have been broken or otherwise injured, and that causes them to sprout badly around the bottom, otherwise they are well formed and are making a healthy vigorous growth. The trees were cultivated and kept in good shape for the first two years after planting, but since then have received no care.

The sizes of the trees on the plat are as follows: 24 are 1 in. in diameter; 54, 2 in.; 89, 5 in.; 44, 4 in.; 17, 5 in.; 1, 6 in.

HARD MAPLE (*Acer saccharinum*). Seedlings—6 to 12 in. high—were collected in the woods in the spring of 1870, and were placed in nursery rows. Though they had been pulled from the light soil of the woods, and were well in leaf, nearly all lived and grew. However, for the first six to ten years the growth of this tree is very slow, even in rich soil, where alone it thrives. After three years in the nursery some of the trees were transferred to the forest and set 2 by 4 ft. apart. Others were transplanted in the nursery and kept there until 1877, when they were placed 4 by 8 ft. apart in the forest.

There has been considerable call for these trees for streets, etc., and the block has been thinned to about 8 ft. each way between trees by digging from time to time for transplanting. In this way the hard maple has credited to it more than any other species. Yet this is a temporary and local circumstance, which must not be taken as of general application.

The small trees first planted were so slow in growth, and care was so long required, that they cost more in the handling and management than did those left in the nursery a longer time. Under ordinary circumstances, it is no doubt best to give the forest-collected seedlings about three years in close rows, then to transplant them in nursery with wider spaces, to remain three or four years longer; then to transfer to the forest. It would be difficult for any one now to detect the difference in shape and size of trunk of those originally set 2 by 4 ft. apart and those later planted from the nursery 8 ft. distant.

All the trees, either in the nursery or afterward in the forest, had the side limbs removed from time to time, and this certainly added to the temporary appearance of the trees for timber purposes and is essential for ornamental purposes, but is really of doubtful expediency in practical forestry, except to prevent forking.

The land upon which these trees are growing is as rich as that of any of the plantation, and fairly good for corn, but sometimes too wet for early planting to this crop. The trees are now growing rapidly, making clean, straight, beautiful trunks, fairly furnished with branches. The shade is less dense than that of the soft maple plat, but mostly on account of the smaller size and less crowded condition of the trees. The shade being so long in developing, many trees and shrubs, like cherries and raspberries, gained considerable footing, while weeds and grasses were not entirely overpowered. Later much of the undergrowth has been crowded out. The height of the better trees in 1886 was about 22 ft., with a circumference of trunk of 9 in. At present, 1893, they are 28 to 32 ft. in height and 4 to 5 in. in diameter. In the first ten years after planting in the forest the gain in height was nearly 20 ft. In the past 7 years the gain has been about 10 ft.

The sizes of the trees on the plat are as follows: 4 are 1 in. in diameter; 34, 2 in.; 43, 3 in.; 62, 4 in.; 28, 5 in.; 4, 6 in.

This shows good results and indicates that more attention ought to be paid to the hard maple in artificial timber growing. The wood is in demand at good prices for the finer uses, such as furniture, building, implements, etc. Too much consideration has evidently been given to its slow growth at the beginning. Its beauty as an ornamental tree is commonly appreciated and acknowledged.

SOFT MAPLE (*Acer dasycarpum*). One-fourth of an acre, in a strip twenty rods long, was planted with three-year-old trees of this variety, two by four feet apart. Nearly all the trees lived and made an average growth the first year of about one foot in height. They have grown very rapidly each season since. Being larger when transplanted, and furnishing almost at once considerable shade, the ground was more easily kept in order than for most others. Cultivation was, however, kept up three years, and there was some needless pruning the second year.

The only thing done with this block since 1874 has been to thin to four feet in the rows and to remove alternate rows, the latter in the fall of 1876. From the low stumps some straggling shoots have grown; otherwise the shade keeps down nearly all undergrowth. The trees prune themselves, and the dead branches soon fall and decay. The trunks are very tall and straight, of nearly uniform height, but vary a good deal in diameter. The difference in the size (diameter) of the outside trees and those surrounded on every side by others is very striking. These trees cast the densest shade of any of the deciduous trees, with the possible exception of the box elder, so that not only are the various shrubs and weeds nearly excluded, but the trees crowd inexorably upon one another. In 1886 the better trees of this species were 42 to 44 ft. in height, with a circumference at one foot from the ground of about 23 in. At present the better specimens have a height of 50 to 55 ft. and a diameter of 9 to 11 in., in one case reaching 18 in. The trees still stand quite thick, having an average of less than 6 ft. sq. each, if only the area intended to be planted by them is taken into account. But, as there are no trees planted along one side and one end, the outside row, in which the largest trees are found, has considerably more space on which to grow.

The sizes of the trees on the plat are as follows: Fifty-six are 3 in. in diameter; 42, 4 in.; 41, 5 in.; 38, 6 in.; 26, 7 in.; 20, 8 in.; 24, 9 in.; 23, 10 in.; 10, 11 in.; 5, 12 in.; 3, 13 in.; 3, 14 in.; 1, 15 in.; 1, 18 in.

When grown as street trees, subject to bruises and wounds, or on account of any serious check in their progress, wood and bark borers are very common in the trunks, where they do much damage. But in the forest plantation not a sign of these depredators existed up to six years ago. At that time the soft maple plat was fenced off, making it a part of a pasture field. Since then there have been some trees damaged by cattle rubbing against them and tramping about the roots, and the borers have begun to make their appearance.

BUR OAK (*Quercus macrocarpa*). In the fall of 1879 acorns of white and bur oak were planted as soon as gathered, but from lack of proper treatment were all lost soon after they started to grow. Two years afterward a quantity of bur oak acorns was gathered and at once planted in nursery rows. These grew well the following season. In the spring of 1884 the tap roots were cut with a sharp spade, the earth having first been plowed away on one side of the row. The next spring the young oaks, two to three feet high, were successfully transferred to the forest, where they are again making very satisfactory growth. During the season of 1890 many of the trees made growths of 3 to 4 ft. in height. The next year the leaves were badly attacked by a fungous disease, and the growth of the trees was much less, but few of them making as much as two feet. It is of course impossible to say how much of this is due to disease, and how much to difference of season.

There was but little disease during the season of 1892, and yet the growth of the trees was but little more than in 1891.

OSAGE ORANGE (*Maclura aurantica.*) Two-year-old seedlings were planted two by four feet apart in the spring of 1871. After the end of the first season they were two feet high, all living and promising. The location was well adapted to the habits of the tree, except that the catalpa crowded upon them on one side and apple trees upon the other. The soil is good corn land, not usually too wet for early planting. In 1876 (six seasons' growth) these trees averaged 13 ft. 6 in. high, and during the last year had gained from three to four feet. Taking into account the well-known value of the wood, it then appeared, and was so stated in a report upon the plantation, that the Osage orange gave every indication of standing first upon the list of timber trees. As a farm hedge plant its superiority had been fully established, and single trees had often been observed to grow into valuable size with satisfactory rapidity.

After the stems have a diameter of 3 in. they are highly prized for stakes, proving very strong and exceedingly durable. With increase in size the value likewise increases for posts, paving-blocks, etc., and finally for various manufacturing purposes. No other wood serves so well for wagons. For turned handles and other purposes where fineness of grain, hardness, and great strength are esteemed, the wood is especially valuable. Added to these uses is that of fuel. The osage surpasses hickory and maple in this respect.

With such characteristics, combined with rapidity of growth, adaptability to our soils, entire freedom from injurious insects, etc., there is little wonder that the species should take first rank among timber trees. But it is always easy to reach conclusions too soon. The later experience with this block in the experimental plantation falls below the anticipated results. About eight years after planting, the growth became much less rapid, and at this time the trees were slender, with long, straggling branches. In 1876 the average diameter of the stems near the ground was recorded as 1½ in. In 1886 the average height is 23 ft., and the average circumference of stems 13 in. Compare this with the larch, over 33 ft. high and 24 in. in circumference of trunk.

At the present time—1893—the better trees are 28 to 30 ft. in height and from 5 to 6 in. in diameter. A few of them have comparatively straight trunks, 15 to 20 ft. high, and most of the trees would make three good posts each. In March of the present year, one-fourth of the plat was cut down, with the expectation of allowing the trees to grow again from the stump. The trees—forty-seven of them—made 116 posts that have sold readily at 10 cents each. The rest of the plat is better than the part cut. The trunks and main branches have evidently grown straighter with age, though they still give but poor promise of making valuable timber trees in this latitude. However, their great durability in the ground makes them valuable as posts, and it is a question if it would not be worth while for farmers to grow small areas of them for this purpose alone. Like the elm and some others, the crowding in a close plantation seems to injure the development of the individual tree; but unless they are crowded, they make a very short trunk, which is soon lost in the branches. If they were judiciously mixed with other kinds it is quite likely that better results would be obtained.

Cultivation was kept up for the first four years, and during this time the side branches were kept trimmed off to facilitate the work to be done. The trees, though irregular in size, are no more so than most of the other kinds. While there is considerable undergrowth of other trees and weeds, there is not so much as under either the ash or walnut.

The sizes of the trees on the plat are as follows: Three are 3 in. in diameter; 40, 3 in.; 42, 4 in.; 43, 5 in.; 16, 6 in.; 8, 7 in.: 3, 8 in.

AUSTRIAN PINE (*Pinus Austriaca*). These trees occupy a strip of land 26 rods long, 36 ft. wide, comprising about ⅜ of an acre. The land slopes slightly to the north; the soil is good and the drainage sufficient in an ordinary season, for successful corn growing. The first planting was done in the spring of 1871, the trees were set 4 ft. apart each way. The young trees, 9 to 12 in. high, had been grown in the University nursery, in shaded beds. Nearly all the trees died the first year. These were replanted in 1872, and again a large proportion died. Nearly all the spaces were finally filled, however, in 1873. Cultivation was kept up until 1875, after which time the weeds were mowed for three seasons.

After gaining a hold on the soil the young trees began to grow very thriftily. In September, 1875, the average height was 2 ft. 8 in. A year later they were 4 ft. 8 in. high. No thinning or pruning was done on them until the winter of 1890–91. During that winter the dead branches were trimmed off to a height of 8 to 10 ft.—as high as a man could conveniently reach with an ax. The dead branches were not all taken off at that time, and they have died since, until there is now an average height of about fifteen feet, on which none are living.

At the same time the pruning was done seventy-three dead trees were cut out. These were principally such as had been overgrown, but some had evidently died from other causes. There are now standing in the plat eighteen dead trees, all small, and there are a good many more of the small trees that do not look as if they would live very much longer. There is more variation in height among these trees than in any other of the evergreens. The appearance of the plat as a whole is not so promising as it was eight years ago, though there are still enough trees in apparently good health, and growing vigorously, to fill the space when they are full grown. The trunks are nearly all straight and erect. None of the leaders were broken off by the sleet storm that injured so many of the Scotch and white pines, and there are no double trees among them.

A few Scotch pines were planted in the plat by mistake and they average much larger than the Austrians.

In 1886 the average size of the better trees was given as: height, 27½ ft. circumference, a little more than 20 in. The same comparative grade of trees is at present 35 to 38 ft. in height and 8 to 9 in. in diameter.

Until about eight years ago the trees were so thick and cast so dense a shade as to exclude undergrowth. Now there is a thick growth of weeds, with some raspberries, Virginia creepers, and other wooded plants.

The sizes of the trees in the plat are as follows: Nine are 2 in. in diameter; 31, 3 in.; 63, 4 in.; 58, 5 in.; 52, 6 in.; 21, 7 in.; 13, 8 in.; 4, 9 in.; 1, 10 in.; 1, 11 in.

SCOTCH PINE, (*Pinus sylvestris*). In the spring of 1871, seedlings of the Scotch pine were obtained of Robert Douglas, of Waukegan, Illinois, and at once set in the permanent plantation, in rows 4 ft. apart and 4 ft. apart in the row. The trees when received were 1 to 2 ft. high, and, as an experiment, they had been grown without transplanting. It was hoped in this way to produce trees at a reduced cost, and the result might have been better under more favorable circumstances, but the soil becoming very dry, and the winds scorching and heavy, nearly all the young trees died.

The next season, Mr. Douglas, without charge, refilled the order with transplanted trees, 12 to 15 inches high, and these were planted as the first lot had been. Again, owing to unfavorable conditions, about two-thirds of the trees died. In the meantime trees had been grown in the University nursery, and in the spring of 1873 the plantation was completed so that very few vacant spaces remained. Previous to 1878 a few trees had been taken out for planting in other places, and considerable numbers had died, so that not more than one-fourth of a full stand remained; these, while not very regularly spaced, have taken such complete possession of the ground as practically to exclude all under growth.

No pruning or thinning of any kind was done until the winter of 1890–91, when the dead branches were taken off to a height of 8 to 10 ft., and the dead trees were cut out. Only eighteen dead trees were found, and nearly all of these were such as had been overgrown and smothered. There are now no dead trees standing. Except on the outer edge of the plat the branches are all dead to a height of 15 to 20 ft.

After the Scotch pines became well established, they made a very good growth—more rapid than either the white or Austrian pines; and they are now larger and appear more healthy and vigorous than either of the others. They are very irregular in their habit of growth, so that there are but few straight trunks with single leaders among them. Their irregular habit of growth was made worse by a sleet storm in the winter of 1882–83, which broke off the leaders of nearly half of them. The trees will incline to straighten some with age, and will probably make timber that will be of value when they are full grown.

As the trees now stand they occupy a space of a little more than 8½ sq. ft. each. In 1886 the better trees were reported to be, on an average, 29 ft. high and a little more than 23 in. in circumference at one foot above the ground. At present the same grade of trees are from 38 to 40 ft. high and 9 to 10 in. in diameter.

The sizes of the trees on the plat are as follows: Three are 3 in. in diameter; 14, 4 in.; 33, 5 in.; 41, 6 in.; 50, 7 in.; 46, 8 in.

The plat on which these trees are growing is quite level, with what surface drainage there is, across the rows. The trees were kept well cultivated until 1875, since when, instead of plowing, the weeds were mowed off twice a year with a scythe.

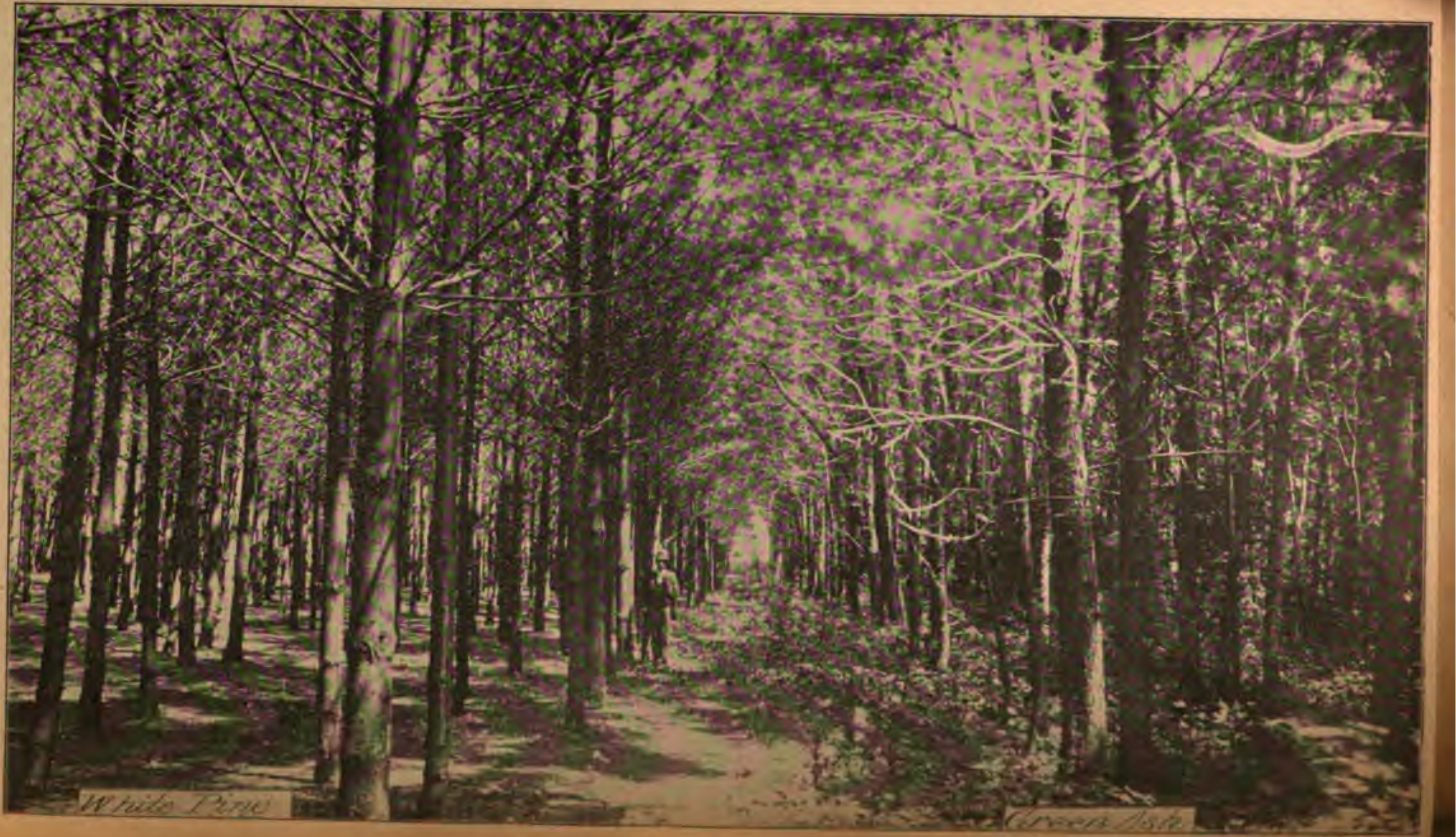
Mr. Douglas writes that these trees were from seeds collected in northern Europe, and belong to what is sometimes called the Riga pine. This statement is important, since it is well known that the *Pinus sylvestris* is very variable, and for timber plantations the varieties differ much in value.

WHITE PINE (*Pinus strobus.*) White pine seedlings were collected in the spring of 1869, put in close nursery rows and shaded with lath frames. About 8 per cent died the first year. Of a few hundred trees, purposely left without shading, 32 per cent died. After having grown in the nursery three years, they were deemed in good condition for transplanting. They were at this time 12 to 15 in. high, well formed, healthy trees.

The land, one acre, where the white pines are planted, is quite flat, what slope there is being to the south; and at least one-half of it is too wet in spring, and often in the early part of summer, for the best results in tillage. The soil is black, part of it mucky, one to two feet in depth, and underlaid, for the most part, with a rather stiff, blue clay. The trees were planted May 4, 1872, 4 ft. apart each way. The white pine is a comparatively hard tree to transplant successfully. The roots are soft, long and naked, with very few small or fibrous roots near the tree. Knowing the necessity of careful handling, no effort was spared, from digging in the nursery to setting in permanent place, to secure successful results.

Throughout the season the ground was kept in a good state of tilth by frequent cultivation, but it was exceedingly dry; and of nearly 3,000 trees planted, two-thirds died during the summer. Of Norway spruce, planted the same day, in the same manner, and on very similar soil, not more than 2 per cent died. It is difficult to explain this greater per cent of loss in the pines, except as we take into account the comparative method of development of the roots of the two species.

In the spring of 1873 the vacant spaces were filled from the nursery, and again in 1874 trees were set where needed. The result of the three plantings was an almost perfect stand of trees. The cultivation with horse and hoe was kept up thoroughly for three years. During the fourth, fifth and sixth years the weeds were mowed. But little cul-


White Pine
Green Ash

tivating was done, because the ground was too wet in the early part of the season.

For a number of years after the white pines were fairly started they made admirable growth, and promised to be very valuable timber trees for the prairie soil here, as well as for their native regions. In a report made in 1886, the following statement is made: "From the first the living trees have done exceedingly well. Very few trees have died from any cause since they began their growth in their present position. They are now remarkably healthy and vigorous, and the plantation vies with that of the larch in beauty and prospective value." At present they are not maintaining the early promise.

No thinning or pruning of any kind was done, except what nature does, until the winter of 1889–90. During that winter and the next the dead branches, to an average height of about 10 feet, were trimmed off, and the dead trees (some more than 350) were cut out. During the winter of 1891–92, sixty-eight more dead trees were cut out, and there are at present fifty-two still standing that have died since the last were cut. The trees cut out the first time had not all died recently. Some of them gave evidence of having been dead for a number of years, while others had died so lately that they still carried dead leaves. Most of the trees that have died were the smaller ones, such as were overgrown or badly crowded. A few only of the larger trees have died. Of the trees still alive, very few have any live branches lower than 20 ft. Many of them have an unthrifty look, either in the top or on tne trunk, and the prospect is that there will be a very considerable number of trees to cut out year by year for some time.

The principal reason for so many trees dying is probably overcrowding. As the trees now stand they occupy a space of less than 7 ft. sq. each. The trees have been damaged in other ways than crowding, but not so far as can be judged, until after they had already begun to die. There is continually a thick mat of leaves on the ground, and these have been partially burned off twice, both times injuring the trees more or less from the ground up two or three feet, but apparently not any higher. Boys seem to delight to cut their names or designs in the smooth bark of the trees. Occasionally a tree is entirely girdled. The girdling soon kills the trees, but most of the lesser damage soon grows over. A woolly plant louse (*Churnus pinicorticis*, *Fitch.*) has been very abundant on many of the trees, attacking the trunks and larger branches for several years. They are sometimes so abundant that the whole trunk has from a little distance a white, or grayish white appearance.

The white pines do not cast so dense a shade now as they did ten years ago. At that time there was no undergrowth among them. At present there are some small wooded plants, such as grape, raspberry, cherry, box elder, etc., besides weeds, coming in, and there would likely be more of these were it not for the heavy mulch of leaves that covers the ground.

In 1886 the average size of the better trees was: Height, 24 ft. 9 in.; circumference, 17 in. At present the better trees are 38 to 40 ft. high and 8 to 9 in. in diameter. During the winter of 1882–3 the leaders of a considerable proportion of the trees were broken down by the weight of sleet. This was the cause of many trees being crooked at that point, and of others having more than one leader. Except for the trees deformed in this way nearly all have almost perfectly straight trunks. The trees are much more nearly uniform in height than in diameter.

The sizes of the trees in the plat are as follows: Fifty-eight are 3 in. in diameter; 194, 4 in.; 256, 5 in.; 236, 6 in.; 144, 7 in.; 70, 8 in.; 11, 9 in.; 5, 10 in.

Norway spruce (*Abies excelsa*). A large lot of small seedlings were put in close nursery rows in the spring of 1870 and grown there two years. In the spring of 1872 a plat of half an acre was planted 2 by 4 ft. in the low ground on each side of the open ditch that crosses the forest. Although the season was so severe with the other evergreens, not more than 2 per cent. of these died. Comparative ease of transplanting, at least when young, seem to be a characteristic of the Norway spruce, while the opposite characteristic seems to be more or less inherent in the pines.

When set, the trees were 12 to 15 in. high. In the fall of 1875, three years after setting, the trees were 2 ft. 8 in. high, and in the fall of 1876, 4 ft. 3 in., and were making a nearly uniform growth. In 1886 the better trees were about 25 ft. high and 16 in. in circumference. At present they are from 35 to 38 ft. high and 8 to 9 in. in diameter.

These trees have almost from the first taken such complete possession of the ground as to exclude all undergrowth, and there is not now another kind that casts so thick a shade as these. All the trees, except those that are badly overcrowded, seem to be in perfect health. As the trees stand at present, they occupy a space of a little more than 8 ft. sq. A few are beginning to be overcrowded and out-topped. After the trees had got well started, probably in the winter of 1877–8, alternate rows were cut out and the trees left to decay on the ground. Trees were taken out as wanted for planting until 1884. Others have been taken out up to the present time for Christmas and other decorations. Many of them were taken for use in other places about the University and grounds, and no charge was made, so it is impossible to estimate exactly the value of the trees used; but if they were counted at the regular prices, the returns from the Norway spruce would not fall much below those from the hard maples. But as such receipts are only incidental, and not to be relied on under ordinary conditions of forest planting, they cannot serve as a general guide as to profits.

During the winters of 1890–91 and 1892–93 the plat was trimmed up to a height of 7 to 8 ft. Only about half the dead branches were taken off. Four dead trees were found, all of them among the very smallest, such as had been completely smothered.

There is some question as to what the trees will be good for after they have been grown. The size and age they are at present, they last but a very short time. After lying on the ground for two or three years they are so brash as to be easily broken in two. Those 4 to 6 in. in diameter very seldom last more than two years in the ground. When the trees are full grown they would probably make lumber that would answer a very fair purpose for rough work, if kept in dry places.

The sizes of the trees on the plat are as follows: Six are 2 in. in diameter; 43, 3 in.; 42, 4 in.; 78, 5 in.; 65, 6 in.; 53, 7 in.; 35, 8 in.; 9, 9 in.; 6, 10 in.; 1, 11 in.

WHITE WILLOW (*Salix alba*). Cuttings of the white willow were put in the nursery in the spring of 1870. The next spring they were put in their permanent place in the forest. The land on which they were planted is low and level, but is fairly well drained by the open ditch that runs across it.

The trees were planted 4 ft. apart each way, and the first year were allowed to grow as they would. In 1872 the young trees were trimmed to a single stem, but being still straggling and crooked they were cut down to the ground in the spring of 1873. The sprouts thrown up from these stumps grew vigorously. More trimming was done on the willows than on any other species of trees in the forest. After a single straight stem had been established for each tree the growth was very rapid. The willows have almost from the first been taller than any other kind of trees in the forest.

Cultivation of these, as of other trees planted at the same time, was thoroughly done with the plow and hoe, until the fall of 1875, since which time but little was done except to mow off the weeds. The trees have always been crooked at the bottom. At from 2 to 4 ft. in height the trunks become nearly, though never entirely, straight. The trees all carry a single leader to the top. The branches are very easily broken off, even when alive, and so the trees have been continually self-trimmed, making most of them practically bare poles all the time. Willows do not naturally make a dense shade, and this trimming makes them still thinner. As a consequence, the trunks from the bottom up are covered with watersprouts that very seldom live to be more than two years old.

About five or six years ago the willows began dying in the tops, and at present nearly half of them are dead; some only in the top, others nearly to the ground. The undergrowth is nearly as dense here as in the ash, but is of a different character. Not less than half of it is poison ivy (*Rhus toxicodendron*). Virginia creeper is more common here, too, than it is anywhere else in the forest. Other wooded plants are confined almost entirely to the black raspberry and wild black cherry.

In 1886 the larger trees were put down as 59 ft. in height and 26½ in. in circumference. The height was probably given a little too great at that time, since the better trees are now only 65 to 68 ft. The best are now 10 to 11 in. in diameter, though a few of those that soon are considerably larger than that at a foot from the ground.

While these trees have made such a good growth, they do not prom- be of much value except for temporary posts or stakes. The wood y soft and light. It does not take a high polish, but still is rather ome when well dressed.

The sizes of the trees in the plat are as follows: Eight are 3 in. in ter; 44, 4 in.; 52, 5 in.; 60, 6 in.; 50, 7 in.; 62, 8 in.; 45, 9 in.; 26, ; 12, 11 in.; 6, 12 in.; 1, 13 in.; 1, 14 in.; 2, 15 in.; 1, 16 in.; 1, 23 in. There is no record as to whether the trees died badly or not when g, but from the irregularity of the stand one would naturally sup- hey did. In 1886 the alternate rows were cut out; but it is impos- to decide now which rows were cut and which were left because sprouts from the stumps. As the trees stand at present they y a space of about 6½ sq. ft. each.

CONCLUSIONS.

Under present circumstances it seems impossible for forest tree ations to be profitable as a farm crop on land fit for wheat and It is idle to talk of growing wood for fuel—except on farms, for use—when good bituminous coal can be had at present prices. fact is, in Illinois, though the extent of the natural forests has been diminished, the price of cord wood does not advance. Lands, though well timbered, sell at a less price per acre than adjoining of the same quality that have been cleared, or than prairie lands of ame productiveness. The value of the timber in such places is less the cost of clearing and bringing under cultivation. It must, how- be recognized that the value of natural forests gives little informa- s to the worth of artificial plantations. The former may be mainly osed of what is in the locality most prized; but it is usual that a proportion only of the trees are those commanding the highest . In the artificial plantation, judiciously managed, the whole may gh-priced, useful material; this, too, may be more readily accessible within easy reach of the market.

Let it be clearly understood that in the foregoing, tree-growing for er has been the point discussed. But the planting of trees has other higher claims. Whether or not the actual amount of rainfall is fied by forests, there is not the slightest doubt but that the climate ected. The temperature is equalized; the extremes of heat and cold not so great. The air is modified as to the amount of moisture, cially in dry times in summer. The moisture of the soil is better ibuted through the year. The running streams are better sustained, also less subject to destructive floods, where the country is well tim- d than where the land is kept bare by cultivation and the surface so ned that the water runs away at once. Heavy winds are greatly ked, much to the comfort of man and animals. Crops are preserved in various ways from the destructive influence of air moving too rapidly. Lastly, trees for the ornamentation of the home area, as well as for the wide expanse of the country itself, can never be neglected by a people whose cultured tastes and educated perceptions give them pleasure in the beautiful and the picturesque. To one who has no love for trees as such, half their value is lost. He who can see nothing but wood for fuel or for the manufactory in a shady grove, sees nothing but the dullest and poorest side of life. While it must be insisted that the figures presented by theorists as to the value of timber as a crop are extravagant, and by no means a proper basis for business, tree-planting for the many and varied purposes of health, comfort and pleasure, with financial profit as a subordinate factor, should be studied and practiced by individuals, communities and nations. It is to be hoped that the experiment of which this account is made will not be considered worthless, if the expenditures are never equalled by the receipts.

There is one reason for uneasiness about this experiment, as there must be about every forest tree plantation. The matter is so serious that this report ought not to be closed without a word upon it. The danger of fire is a real and imminent one. The areas bearing the conifers are liable to be burnt over during any dry time, and in autumn, after the fall of the leaves, the portions devoted to deciduous trees are quite as unsafe. A burning wad from a gun, a spark from a pipe, a negligent use of fire by a tramp, may be sufficient to start a conflagration which shall destroy within a few hours the products of years and decades. The incendiary has an abundant chance for the practice of his most despicable and criminal acts. In Europe there is some protection in the ***gens d' arms;*** American police only beat the thronged streets far away from the farms. Our plantations would not multiply fast if it were understood that a guard must be furnished night and day. It is impracticable to gather the fallen leaves and branches, which, moreover, are necessary as a mulch for the best growth of the trees. There seems to be little offered but to take the risk. If so, this must be included among the items of obstacles and expenses.

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COLLEGE OF AGRICULTURE
UNIVERSITY OF CALIFORNIA

BULLETIN
OF
The New York State College of Forestry
AT
Syracuse University

The Planting of Forest Trees by the Public Schools of the State

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Forest Day for the State to Supplement Arbor Day

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Photo by Hugh P. Baker

VIRGIN FOREST IN THE NORTH ATLANTIC STATES

This is a bit of the forest with which Nature covered the great State of New York. Unfortunately
re are but remnants here and there in the State of this wonderful original forest.
The establishment of miniature forests by the school children of the State will bring back
re and more those original conditions and actually establish near every community conditions
ch will bring the spirit of the forest not only to the children who carry on the work, but to the
ire community.

PLANTING OF FOREST TREES BY THE PUBLIC SCHOOLS OF THE STATE

For a number of years it has been the custom on the first Friday in May of each year for the school children of the Commonwealth to plant one or more shade trees or groups of ornamental shrubs on the grounds surrounding the public schools. Those who introduced this custom believed that the planting of a few trees and shrubs would impress upon the boys and girls of the State the importance of trees in the life of the community, and that constant contact with trees and shrubs which the student had planted with his own hands would create in him a love for nature and for the great out-of-doors.

In many communities Arbor Day has meant much and its observance has resulted not only in a beautification of the school grounds, but in the interesting of many girls and boys in trees and outdoor things generally. The idea of Arbor Day originated in Nebraska, where trees do not grow as easily as in New York and where there have always been fewer trees and therefore a greater need for them.. The transfer of Arbor Day bodily from Nebraska to New York has meant that it has not been accepted in many communities because not needed. Many school grounds are already sufficiently planted, and it is to these schools that the College of Forestry appeals especially for the planting of a school forest by the pupils.

The Department of Education of the State of New York has done a great deal in stimulating interest in the celebration of Arbor Day in the past, and it has larger plans for a continuation of an Arbor Day celebration in the schools of the State. There are still many school grounds which need ornamental trees and shrubs, and important lessons may be taught the children through the carrying out of Arbor Day exercises. The New York State College of Forestry at Syracuse University, which was established for the purpose of giving educational work in forestry throughout this State, is in a position to supplement and carry forward the splendid work being carried on by the Department of Education in the observance of Arbor Day. It hopes, therefore, not only to stimulate greater interest in Arbor Day by co-operation with the State Education Department, but it proposes to supplement and end the work begun on Arbor Day by assisting schools in the nting of a thousand or more forest trees so that each school y have a miniature forest of its own. The College is therefore ing this rather brief announcement with a hope that the high ools especially of the State may become interested in making planting of trees in the spring something more than a day of rcises and possibly the planting of trees upon grounds already l shaded.

E IDEA OF A FOREST DAY TO SUPPLEMENT RBOR DAY DEVELOPED THROUGH NEED OF PROTECTION OF THE FORESTS OF THE STATE

For several years the College of Forestry has been teaching ough the State the necessity for protecting the forests owned the State in the Adirondacks and Catskills from fire, and, fur- r than this, has been urging the development of a State-wide est fire law. It has not met with opposition to these ideas on the t of the people, but it has met constantly with indifference not y from those who own the forests but those who seek the ests for the game they contain or for recreation. As the efforts forest protection through the State continue it becomes ever re apparent that if permanent results are to follow the educa- nal work done by the College, the children of the State must be ght not only to love the trees but to believe in them as trees l as forests for the value which trees and forests have for the te. The College feels that if the boys and girls will take part he planting of a thousand small trees on some bit of idle land the vicinity of the school, very much has been done for the tection of the forests of the State. Boys and girls who have nted a miniature forest and watched the trees grow are not ng into the forest and leave a burning camp fire or throw down urning match. Furthermore, they have taken part in a piece real constructive work for the State and have been introduced an effective way to the problem of the utilization of the idle ds of the State.

HOW TO BEGIN A SCHOOL FOREST

It is not the idea of the College that the starting of a School rest or the development of a Forest Day in the State shall take the place of Arbor Day or the exercises which have been held through the years upon this Day. The idea of a School Forest for every school in New York is urged by the College as a step beyond what could be successfully carried out in the State before the organization of a strong State College of Forestry to guide the development of this work. The College will co-operate in every possible way with the State Department of Education in its celebration of Arbor Day in the schools and then hopes to guide the next step beyond, which will be the development of a Forest Day, not necessarily coming at the same time as Arbor Day, but at the time best suited to the planting of forest trees.

The idea of planting from one to five thousand trees on some bit of idle land in the vicinity of the school building is generally new to the great mass of pupils in high schools and other public schools, yet some of the schools of the State have been holding a Forest Day for the past three or four years and some schools have already planted from one to ten thousand trees under the direction of Foresters from The State College of Forestry at Syracuse. Two years ago the school children of Hornell set out some 25,000 trees on the city water shed seven miles from Hornell. The people of the city were very greatly interested in this Forest Day, took the children from the city to the future forest in motor cars and did all in their power to make the day a success.

The Boys' Conservation League of Glens Falls, New York, made up of a group of school boys, plants each year from one to three thousand trees on idle lands both within and without the city limits. The League developed this idea several years ago and some of the trees planted are now five or six feet in height, giving the boys the pleasure of seeing results of their labors, and they are realizing, therefore, to a surprising extent the part they are playing in real constructive conservation for the State. The school children of Jamestown have actually purchased a School Forest of 100 acres and have already begun some forest work on their "One Hundred Acre Tract."

In nearly all of the work done so far in the State along these lines, the women of the communities interested have been very influential in seeing the work successfully carried out.

LAND SUITED FOR PLANTING NOT DIFFICULT TO LOCATE

With few exceptions, high schools and other public schools interested in beginning a school forest will find pieces of idle land the form of barren ridges or hillsides in the vicinity of the ıool, the owners of which will be very glad to have planted to est trees. The nearer the school that these plantations can be ated the greater the interest the school will take in the planting. such pieces cannot be found there are often idle lands about city reservoirs or in undeveloped portions of city parks. A le inquiry on the part of the instructional force of the school the boys themselves will bring to light locations where plantings y be done. In some instances it may be possible to find bits of te land so close to the school that they may be secured from State for School Forest purposes, or permission may be nted by the State for their use by the school.

CURING THE TREES AND ESTABLISHING THE FOREST

The State of New York, through its State Conservation Comssion, leads the States of the Union in the development of est nurseries and reforestation work. The Conservation Comssion will sell forest trees ready to plant to the citizens of the te practically at cost. It grows these trees in State nurseries different parts of the State. One of these is located on the te Forest Experiment Station maintained by The State College Forestry just south of Syracuse. This nursery has been deoped in co-operation between the Conservation Commission l The State College of Forestry and is capable of supplying eral hundred thousand trees annually. Trees of sufficient size plant in school forests of such rapid growing kinds as White ıe, Red or Norway Pine and Norway Spruce may be secured from $3.50 to $5.00 per thousand. Application may be made ectly to The College of Forestry at Syracuse or to the State nservation Commission at Albany.

It is probable that the future forests of the State will be made of a few rapid growing evergreens and hence the suggestion t the School Forest be planted to these evergreens. We can, a rule, grow two good evergreen trees to commercial maturity ile we are growing one broadleaf or hardwood such as the h, Hard Maple or Elm. Should schools prefer to plant hardods it will be possible to supply to some extent seedling trees White Ash, American Basswood or Linden, Whitewood or

Tulip, and Red Oak. The hardwoods will be seedlings from one to three years old and the evergreens will be transplants from two to four years old.

Upon the receipt of the trees at the School the box or basket should be opened, and if the planting is to be done within the next day or two, it should be placed in a cool shed or cellar. If it is not possible to do the planting for several days then the trees should be taken out of the basket and the roots buried carefully in fresh soil. If a trench is dug, preferably in the shade of a building or on the east or north slope of a hill and the roots placed in the fresh mineral soil in the trench and fresh soil placed back against the roots and thoroughly packed against them, the trees can be kept in good condition in this way for several weeks if necessary. This process is known as "heeling in."

When the planting is to be done the trees can be lifted out of the trench with a spade or mattock, not pulled out, placed in pails with the roots in water or in baskets, with the roots kept covered with moist moss or moist sacks. Three or four good husky boys will plant easily one thousand trees a day.

THE STATE COLLEGE OF FORESTRY WILL SEND A FORESTER FOR THE SUPERVISION OF THE PLANTING OF THE SCHOOL FOREST

If schools will write to The College of Forestry at Syracuse, suggestions will be given as to the kinds of trees to plant in different soils, where and when to get them and how they may be planted if a Forester is not present to help. The College will be very glad to send out a trained Forester to supervise the planting where the school will plant at least a thousand trees.

The usual way of planting trees is to divide the boys up into groups of 3 or 4 so that one may keep the alignment, one or two dig holes and one do the planting. The usual distance of planting in a school forest is 6 x 6 feet. This will call for 1,210 trees to the acre. When planting great care must be taken to remove the duff or sod from the surface, and unless the roots of the little tree are put into the fresh mineral soil and the soil firmly packed around the roots so there will be no air spaces, the little tree is apt to dry out very quickly. A little care used just at the time the roots are t into the ground will mean a great deal in the development of · little tree. Trees grow like weeds in New York and success planting is largely a question of getting the roots firmly placed fresh mineral soil at the beginning. With proper planting and linary weather conditions, about 90 to 95 per cent. of the little es should live, and unless the growth of grass and brush is ex-dingly heavy where the trees have been planted, it will not be essary to do anything more than to protect the trees from fire l from being trampled by horses and cattle.

After the trees have been planted they grow very rapidly and vill be but two or three years before the boys and girls will see practical results of this constructive work. The necessity for practice of forestry in New York is no longer a question and College feels sure that once the boys or girls become interested a forest plantation they will take the right attitude toward the ests of the State and will understand what Foresry means and at the forests may accomplish for the State, not only in the y of producing lumber but in conserving the water supply of State and in developing recreation places for the people.

PLAN EARLY FOR FOREST DAY

It should not be difficult to find some public spirited citizen o will be glad to turn over one to two or three acres of land for development of a school forest. If this is not possible, take the matter with the city officials to see if there are not sections undeveloped parks or land about the reservoirs where planting uld be an advantage from every standpoint.

After securing the land, the College suggests that the principal the School write, giving accurate description of the soil and isture conditions of the area. It may be well, where it is diffi-t to describe the soil, to send a small sample of it by parcel st. The College will then make general suggestions as to the es suited for the particular school forest. An order sheet will sent by the College which may be used for ordering the seed-gs and this may be filled out and sent directly to the College or the State Conservation Commission at Albany.

The College will suggest a day for the planting, depending on weather conditions, and after the day has been settled upon the school, arrangements will be made for a Forester from the

College to guide the students in the planting. It may be desirable to have a talk for the students during the day on Forestry.

The Forester will plan to get to the School the night before or early in the day so as to go over the ground, and will try to meet the older boys so as to organize them into planting groups. It is suggested that the girls assist in the planting either directly through carrying the trees for the planting or in furnishing the lunch for the boys who plant. Before the planting is started the Forester from the College will be glad to give a talk either in the school or in the open on "Trees and what they mean to the community," or will give a more formal illustrated lecture on "Forests and Forestry in New York." The College believes that much can be done in schools in awakening interest in the many phases of the activities of the State through the starting of a School Forest.

WHERE SCHOOL GROUNDS ARE NOT FULLY PLANTED THE COLLEGE URGES THE OBSERVANCE OF ARBOR DAY BY THE PLANTING OF ORNAMENTAL TREES AND SHRUBS

There is nothing that adds, by so small an effort, so much to the attractiveness of the landscape of New York State, as the planting of good, long-lived shade trees. The most pressing needs for the presence of shade trees are along country roadsides, village and city streets, town commons, village greens, city squares, rural cemeteries, recreation areas, play grounds, and school grounds. The New York State College of Forestry will be very glad to assist in helping to lay out school grounds in the city and in the country, so that proper provisions may be made for a good growth of trees and by recommending the best sorts for special purposes. It is desirable to surround the buildings in which the youth of the State spend a large part of their time, with fine trees, properly planted and cared for. The impression made by beautiful surroundings is as essential to the proper development of our children's training as the providing of comfortable and sanitary buildings and good text books and teachers. School Boards, teachers and children as a rule are glad to improve school grounds if there is someone to suggest how this may be done with reasonable expenditure. Some of the best varieties of shade trees to plant are Norway Maple, Oriental Sycamore, Pin Oak, Red Oak, and Ailanthus for the cities; American Elm, Sugar Maple, Hackberry, White Ash, Red Maple, and Tulip Tree for the towns and villages. The trees recommended for the cities can be best obtained from some nearby commercial nurseries. The varieties for town and country use may be secured from the fields and woodlands, although as a general rule, in this case only the small sizes should be transplanted. It is usually possible to interest Village Improvement Societies, Women's Clubs, and other Civic organizations in giving support to tree planting campaigns. Where a quantity of shade trees are to be planted arrangements can sometimes be made to secure free aid from the State through The New York State College of Forestry at Syracuse, N. Y.

OTHER HELPS IN INTERESTING STUDENTS IN FORESTS AND THEIR PRODUCTS

The State College of Forestry at Syracuse has prepared a set of 30 different hand specimens of woods of the State. These are 3" x 5" and a little less than ½" thick. Each specimen is carefully labeled and numbered and the label gives the common and technical name of the tree, its distribution and use. With the set comes a little pamphlet describing the structure of the wood and making special reference to the set of woods. This set of woods will be furnished to any school or club in the State wishing them at cost, which includes transportation. This cost is 50 cents. At all times the College will be glad to identify, at no cost, specimens of trees and shrubs and pieces of wood.

The College is preparing for distribution also a set of some 30 different kinds of tree seeds. These are put up in small glass vials, carefully labeled and will be shipped in a block of wood, each vial in a compartment by itself, so there will be no danger of breakage, and the set will be very easily handled in the school. This set of seeds, with the pamphlet describing them, will be sold at cost which will be the same as for the woods collection.

THE COLLEGE OF FORESTRY WILL IDENTIFY SPECIMENS OF TREES, SHRUBS AND WOODS

It may be that there are trees or shrubs growing about the school buildings or on the grounds about the homes of the boys and girls which are not known to them. It may be that certain woods are being used in manufacturing plants in the city or in repairing the school buildings or the home buildings which are not known to the pupils. The College will be glad at all times to identify specimens of trees and shrubs and the woods, giving both the common and scientific names. If possible, with trees and shrubs send in small specimens of leaves, buds, and flowers or fruit if they can be obtained. A small piece of wood two or three inches long and an inch thick will be sufficient. It should be possible for the children of the school, through the aid which the College can give in identification of trees to get acquainted with the trees of the entire community. Possibly the school may wish to assist in making a tree census in the community as well as aiding in the proper labeling of trees in the parks or about the public buildings. The College will supply tree and shrub labels of uniform size giving common and scientific names, and these at cost.

PROPERTY OF DIVISION OF
FORESTRY
COLLEGE OF AGRICULTURE
UNIVERSITY OF CALIFORNIA

THE NEW YORK STATE COLLEGE OF FORESTRY

AT

SYRACUSE UNIVERSITY

Designated and supported by the State as the Institution for educational work in Forestry in New York.

OFFERS AT

SYRACUSE UNIVERSITY

FOUR AND FIVE YEAR PROFESSIONAL COURSES,

Leading to degrees of Bachelor of Science (B. S.), Master of Forestry (M. F.) and Doctor of Economics (D. Oec.).

At the State Ranger School on College Forest of 1,800 acres at Wanakena, in the Adirondacks, a one-year Ranger Course.

On Cranberry Lake, in the Western Adirondacks, the August Forest Camp, where anyone interested in the woods can get a month of directed recreation along forestry lines.

As a part of its State-wide educational work, the College offers to make plans for the protection and management of timberlands and woodlots and for the reforestation of cut-over and barren areas. Where the timberland, or woodlots, or barren areas are between 300 and 1,000 acres or over, and where there is a reasonable assurance that plans will be carried out, they will be made at no expense to the owner. Where there is less than the above amount, it will be necessary for owners to pay expenses of traveling and sustenance while the plan is being made. Owners of small tracts may combine and by bringing the area to 300 or more acres, have plans made without cost.

The College invites correspondence at any time as to its educational work or regarding the protection and management of forests or woodlots, tree planting, forest insects and tree diseases, and timber treating.

28 15-1-15

All offers made and orders accepted subject to goods being unsold and to the extent of crops

THE D. HILL COMPANY, Inc.
TREE SEEDSMEN
COLLECTORS AND EXTRACTORS
IMPORT EXPORT
DUNDEE, ILLINOIS, U. S. A.

D. HILL, PRESIDENT
FOUNDED 1855
INCORPORATED 1910

CABLE ADDRESS:
HILL, DUNDEE, ILLINOIS
A. B. C. CODE, 5TH EDITION

January 1, 1916.

SPECIAL TREE
SEED OFFERING

For prompt orders, we quote today, the following items. All seeds are fresh, clean and of good germination.

				Lb.	10 Lbs.	Cwt.
Abies Douglassi	(Douglas Fir)	Wash.	@	$2.75	$25.00	
Abies Concolor	(Concolor Fir)	Colo.	@	2.00	17.50	$150
Juniperus Glauca	(Silver Cedar)	Colo.	@	.50	3.50	25
Larix Europea	(European Larch)	Europe	@	2.75	25.00	
Picea Englemanni	(Englemann Spruce)	Colo.	@	3.75	35.00	
Picea Excelsa	(Norway Spruce)	Europe	@	1.85	17.50	
Picea Pungens	(Blue Spruce)	Colo.	@	4.00	37.50	
Pinus Austriaca	(Austrian Pine)	Europe	@	2.50	22.50	
Pinus Banksiana	(Jack Pine)	Minn.	@	3.50	30.00	

Pinus Strobus	(White Pine)	Wis.	@	2.50	20.00	185
Pinus Sylvestris	(Scotch Pine)	Europe	@	2.50	22.50	
Thuya Occidentalis	(Am. Arbor Vitae)	Wis.	@	2.75	25.00	
Taxus Cuspidata	(Japanese Yew)	Japan	@	3.00	27.50	
Catalpa Speciosa	(Hardy Catalpa)	Ill.	@	1.00	7.50	
Juglans Nigra	(Black Walnut)	Ill.	@	.10	.75	5
Prunos Serotina	(Wild Blk. Cherry)	Ill.	@	.25	1.50	12
Robinia Pseudocacia	(Black Locust)	Europe	@	.75	6.50	
Cornus Amomum	(Silky Dogwood)	Ill.	@	.50	4.00	
Syringa Villosa	(Himalayan Lilac)	Ill.	@	.85	7.50	
Viburnum Dentatum	(Arrow Wood)	N. Y.	@	.60	4.50	
Viburnum Prunifolium	(Black Haw)	N. Y.	@	.75	5.00	
American Apple Seed		Vermont	@	.50	4.50	
French Crab Apple Seed		Europe	@	.50	4.50	

½ lb. at lb. rates; 5 lbs. at 10 lb. rates; 50 lbs. at 100 lb. rates. Bags extra--at cost. Our prices as usual are reasonable and all seeds are fully tested for purity and germination.

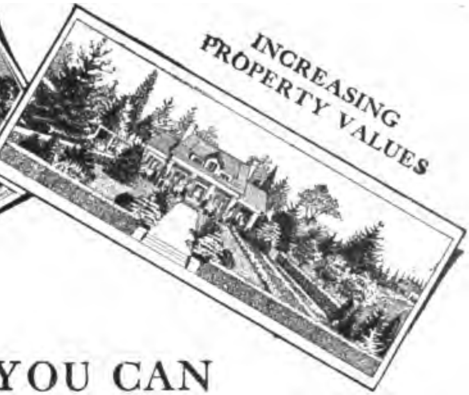
War or no war, you will need Tree Seeds and now is the time to place your order while supplies are available and prices low.

Just indicate opposite each variety the quantity you desire, return sheet and your order will receive immediate attention.

Very truly yours,
THE D. HILL COMPANY.

While we exercise the greatest care to have our seeds, plants, etc., pure and reliable, they are sold without any responsibility, expressed or implied, in respect to the crop. If the purchaser does not accept the goods on these terms, they must be returned to us at once and money paid us for them will be refunded. Germination annalysis when stated will be according to Washington Tests.

HIDING THE BARE FOUNDATION WALLS



HOW YOU CAN
USE HILL EVERGREENS AROUND YOUR HOME OR FARM

One picture is worth ten thousand words. These five speak volumes. Each one shows how you can profitably plant Hill Evergreens around your home or farm. They do more. Each picture tells why you will profit by planting Hill Evergreens. Study them carefully. Then turn to pages six and seven and see there the best varieties to plant in your locality.

PLANT HILL EVERGREENS FOR ALL PURPOSES

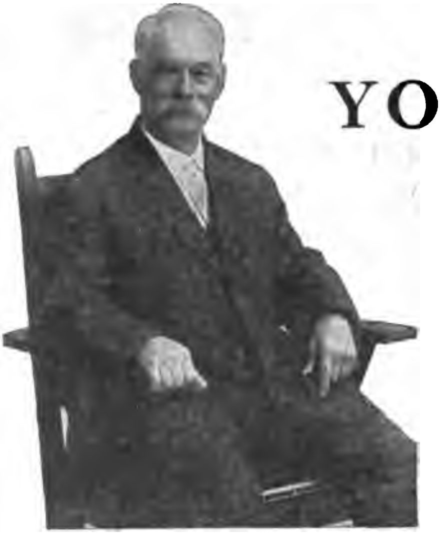
Evergreens will bring a new beauty and charm to your home and farm. Planted around your house, in the yard or around the barn, garden, orchard and fields they will actually transform your place. Homes and farms generously planted with Evergreens always bring higher prices than other places. Evergreens are an "all the year round" tree, serving you faithfully and efficiently through each season of the year.

THOSE WHO PLANT HILL EVERGREENS
ARE ALWAYS SATISFIED

HILL'S EVERGREEN BOOK

EVERGREENS

FOR
YOUR HOME
AND
FARM



D. HILL
The Evergreen Specialist

HOW THEY WILL IMPROVE AND BEAUTIFY YOUR PROPERTY

❡ Each year I send my Evergreen Book to thousands of the country's most progressive men and women. With each one I send a sincere message of friendly interest and good fellowship. This catalog carries that message to you—on every page—in every one of the many suggestions for the improvement of your home and farm.

❡ Many of you already know that for over half a century I have devoted all my time to growing only Evergreens. To those it is no new story of how, in 1855, right here in Dundee—the most ideal climate and soil in the United States for the growing of Evergreens—I began with only a few acres and fewer trees.

❡ Today there are more than fifty millions of Evergreen Trees under constant cultivation on the four hundred and fifty acres that now are used exclusively for my Evergreen Nursery.

❡ For over half a century the home-loving, progressive farmers of this country have been writing to me for advice about Evergreens—asking me to help them in their plantings—consulting me about the best ways of improving their homes and surroundings.

❡ I have answered hundreds of these letters. I know many of the writers personally—for in my own farming, and in my years of experience with other farms, I have helped plan many attractive and useful Evergreen plantings.

¶ I want you to feel just as free to write to me as my other friends do. I will gladly help you in any way I can. Write to me personally—freely—just as you would to a friend.

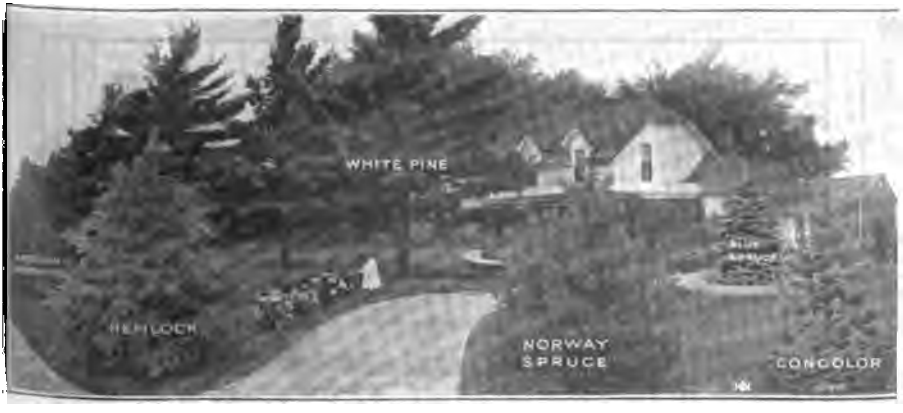
¶ As an ornamental tree, Evergreens are unsurpassed. No other trees remain green through summer and winter; none are more beautiful. But, while their value in this respect is great, Evergreens are most useful in other ways.

¶ They protect houses, stock and crops, from wind, sun and snow. They conserve the soil's natural moisture. They form a substantial shelter and nesting place for the birds that rid your acres of worms and destructive insects. They are a source of salable timber for fence-posts and other uses.

¶ And as an investment that brings large cash returns in the increased value of your property, there has never yet been found—nor will there ever be—a more satisfactory and less expensive a tree, so particularly adapted for farm purposes.

¶ And when I tell you that every State Agricultural Experiment Station, every Agricultural College—even the Department of Agriculture at Washington, D. C.—will give you the same facts about Evergreens as I do, I am proving conclusively that unless you have already planted Evergreens on your farm, you should at least investigate the great value these most useful and ornamental trees have for improving your property and making it a more attractive and prosperous-looking place.

D. Hill **President**



A good example of Evergreen planting both for protection and ornament. This is a re

WHERE TO PLANT EVERGREE

SOME FACTS EVERY

BEAUTIFY YOUR HOUSE

℄ Could anything be more attractive than a home tastefully decorated with living Evergreen trees, that hide the bare foundation walls of house or porch? And with a few Evergreens planted to liven up the dull places and with a hedge along the front walk, there is nothing else that will so quickly improve your home as inexpensively. Hemlock, Dwarf Mugho Pine, American Yew and American Arbor Vitae are unexcelled for foundation and hedge planting. They all can be trimmed to any height and shape.

HEDGE AND LAWN PLANTING

℄ Evergreens call forth sincere admiration in every season, and the home with well-planned plantings possesses a distinctive beauty eternally satisfying to the owner and increasing the value of his place all out of proportion to their low cost.

℄ Hill Evergreens are planted singly or in groups on the lawn. You have a wide range of selection—both in variety and price. And you can quickly transform your home surroundings into a fragrant and permanently beautiful place. For hedges use American Arbor Vitae, Norway Spruce or Hemlock. These varieties are most popular. For planting singly or in groups, these varieties cannot be excelled: Colorado Blue Spruce, Concolor Fir, White Pine, Jack Pine, Douglas Fir, Scotch Pine, and Red Cedar.

A good way to group Evergreens on your lawn

D WHAT VARIETIES TO USE

FARMER SHOULD KNOW

SHADE YOUR YARD

℄ Evergreens are satisfactorily used for shade trees. But because many folks only think they cannot be used in that way, this fact is not generally known. And their use has become a welcome addition to many homes, in that the limbs and dense foliage of Evergreens form a cool, sheltering playground for the children. And in addition, wherever there is a bare spot plant an Evergreen tree. The results will astonish you for quickly transforming your yard into a most delightful place. You will find Norway Spruce, American White Spruce, Austrian Pine, Douglas Fir and Red Cedar most satisfactory trees for these purposes.

LANDSCAPE YOUR PLACE

℄ The variety of Evergreens, some low, some medium, and some high growing, and the fact that many varieties yield readily to shearing and can be kept at any height desired or trimmed to any shape, permits of beautiful effects impossible to secure with other shrubs and trees.

℄ For medium height varieties around the house: Hemlock, Douglas Fir, and Concolor Fir. Of the higher trees, Norway Spruce, White Pine and Red Cedar are excellent selections.

Evergreens make ideal lawn and garden hedges

HILL EVERGREENS AR

THEY ADD DOLLARS TO THE

IMPROVE YOUR GARDEN

¶ Plant a row of Evergreens on the windward sides of your garden. Vegetables which would not mature in the windswept garden can be grown in the protected one. The productiveness of the entire garden is greatly increased.

¶ American Arbor Vitae makes an ideal garden hedge, also serving as a low windbreak. The dense growth keeps out chickens, dogs and other intruders. Norway Spruce, American White Spruce and Douglas Fir are also used extensively for garden planting.

WINDBREAKS FOR SHELTER

¶ A Hill Evergreen windbreak sheltering the barn, barnyard, pastures and stock runs, takes the sting out of bitter weather for both man and beast. The houses are kept warmer with less attention to fires and less fuel. Livestock is kept comfortable and thriving. Your cattle, horses, sheep and pigs eat less and their food goes into growth. Chickens lay better because of being sheltered from penetrating winds, and the bees will benefit through the increased protection during the winter.

¶ Norway Spruce, American White Spruce, Black Hill Spruce, White Pine, Scotch Pine, Austrian Pine, Jack Pine, Ponderosa Pine, Douglas Fir, or any of the tall and medium growing Evergreens are the varieties to use for these purposes.

A money saving Evergreen Windbreak protecting huge barn, garden, house and chicken yard

HE NATIONAL FARM TREE

VALUE OF ALL FARM LAND

PROTECT YOUR ORCHARD

¶ A Hill Evergreen windbreak will protect your orchard and prevent many bushels of fruit blowing off your trees. The fruit will color and develop better. Spraying can be done on windy days in protected orchards. An Evergreen windbreak is the best, cheapest and most effective insurance an orchardist can get.

¶ For an orchard windbreak use Norway Spruce, American White Spruce, American Arbor Vitae and Ponderosa Pine.

INCREASE YOUR CROPS

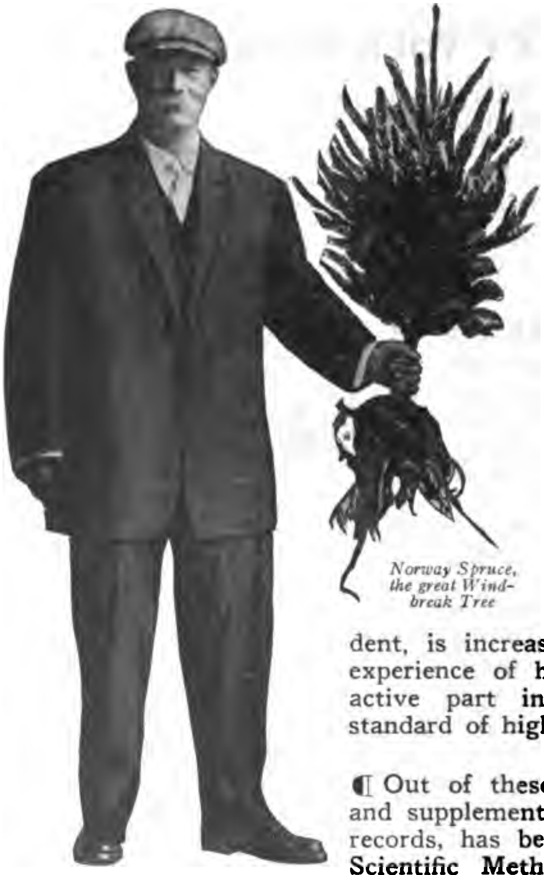
¶ It is a well known fact that Evergreens planted between fields and along fence lines insure larger crops, quicker yields and a surer growth of grain. And for protecting insect destroying birds, Evergreen trees form a splendid nesting place.

¶ Crops heading out will not "lodge." This protection extends for a long distance from the windbreak. Crops will grow better, because the windbreak lessens the force of wind and also conserves moisture. The increased yield of both crops and pastures in a single season will more than pay for a Hill Evergreen windbreak.

¶ Norway Spruce, American White Spruce, Black Hill Spruce, White Pine, Scotch Pine, Austrian Pine, Jack Pine, Ponderosa Pine, Douglas Fir and European Larch are excellent trees for field and pasture windbreaks.

This orchard and garden are safe from the icy blasts and destructive winter winds. They are protected by a solid wall of Spruce foliage.

HOW HILL GROWING METHOI
HILL EVERGREEN TREES ARE



Norway Spruce, the great Windbreak Tree

Showing Mass of Fibrous Roots Developed by Hill Scientific Methods of Growing

❡ Thousands of words — volumes — could be written on the "whys" and "hows" of Hill Growing Methods. But a short, simple statement of the various steps will be more interesting.

❡ From the beginning of this Evergreen Nursery in 1855, the Hill name has been associated with Evergreens. Experts have been in charge of the different departments. And the long experience of Mr. D. Hill, President, is increased by the study and experience of his sons, who play an active part in upholding the Hill standard of high quality.

❡ Out of these years of experience, and supplemented by careful growing records, has been developed the Hill Scientific Method of growing Evergreens, and today no other means are employed on our place.

SEEDS

❡ Only those seeds are used that come from the best latitudes, that assure healthy trees of absolute hardiness. And nothing but the highest quality of Evergreen seeds of the most life and vitality are ever planted.

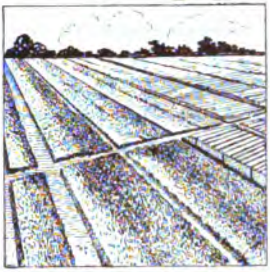
PLANTING

❡ These seeds are planted in beds of especially prepared ground. When the seeds germinate, and the little seedlings push their way through the surface of the soil, they are painstakingly watched, and protected, until they are old enough and strong enough to be moved into a larger space that gives them still more room for top and root growth.

KE YOUR SUCCESS CERTAIN

GUARANTEED SATISFACTORY

DOUBLE TRANSPLANTING


Seed Beds, Hill Nursery

¶ Hill Evergreens are twice transplanted before being offered for sale. This, together with the root-pruning they receive, insures strong, healthy, sturdy stock. Root pruning and transplanting are the only known methods of producing a tree that has masses of fine, fibrous feeding roots. Our experience has taught us how to best produce these fibrous feeding roots.

ROOT PRUNING

¶ Shortly after Hill Evergreens have first been transplanted, they are root-pruned. Our experience has shown that the most satisfactory method of root-pruning does not necessitate the removing of the Evergreens from the ground. Hill root-pruning is done underground by a special implement, and does not disturb the tree in any way, but benefits its growth.

CARE DURING GROWTH

¶ Every year, throughout the entire growing season, the various blocks of Evergreens are under constant cultivation. No weeds are allowed. Every particle of nourishment in the soil goes into the growing trees.

¶ To produce Evergreens that will measure up to the standard of Hill "quality" requires the most painstaking care and attention. Trained experts constantly watch and guard their growth.

WHY HILL EVERGREENS AR

QUALITY THE HIGHEST

NO WEAKLINGS

❡ Any tree that is a weakling will not survive the various processes described and will naturally be eliminated. This accounts for the high quality of Hill's Evergreens. This is the secret of Hill's Evergreens' certainty of growth. For no other than a strong, healthy, sturdy tree can stand the successive transplanting, root-pruning and second transplanting. They die of actual starvation, for lack of sufficient roots to feed them. And only the heavily rooted Evergreen trees survive.

❡ Many nurserymen either do not realize the importance of this or are unwilling to spend the money necessary for the same care and attention as we give our stock.

Hill Transplanted Evergreen Tree. Notice the strong fibrous roots and bushy top

IMPORTANCE OF CAREFUL DIGGING

❡ It is at this stage in the growth of Hill Evergreens, when the trees are from six inches to three feet in height, according to variety, that they are ready to ship to you and give satisfactory results. Evergreen trees of this size are most satisfactorily and economically handled and shipped. In preparation for shipment the trees are dug with the greatest care by the use of specially constructed horse-drawn digging machines, which carefully remove the trees from the ground, retaining all the fine, fibrous feeding roots. This is one of the most important steps in successfully handling Evergreens. It is just as important that all the fine, fibrous feeding roots are skilfully dug up uninjured, as it is that these trees get a chance to grow these fine, fibrous feeding roots.

❡ Customers living at a distance invariably express surprise and gratification at the excellent condition in which shipments arrive after a long journey. The Hill quality of stock and the Hill method of digging, handling and packing—THAT'S THE ANSWER.

Hill "quality" is the highest obtainable. It is the accepted standard. There is no better. No other firm can supply you the same high quality Evergreens for the same price. Our enormous yearly output, together with the perfection of an organization trained to but one object—the cultivation of Evergreens—enables us to make our prices the lowest obtainable for satisfactory trees.

VERY MUCH IN DEMAND

PRICES THE LOWEST

Packing

PACKING

¶ Then these Evergreens, freshly dug, are taken immediately to packing rooms—away from exposure to wind and sun, ready to be sorted, graded, labeled and prepared for shipment.

¶ Hill Evergreens, when prepared for shipment, have their roots carefully packed in damp, genuine peat moss. Why? Because moisture cannot be conserved in any other way—a fact acknowledged by every tree expert.

¶ Then the Evergreens are put in a suitable box or bale. This prevents the trees from shaking around; keeps the roots of each one safely secured in its peat moss bed; gives every tree plenty of pure, fresh air, and prevents them from overheating. Thus they are in first-class condition when they reach you.

SHIPPING

¶ It's care all the way through, from beginning to end, that is exercised. And no nursery in the world gives such care at every stage of the growing, digging, handling and packing as we do. None of them insist on the little extras that we use to preserve life and strength. Buy your Evergreens direct from true Evergreen Specialists. Save $3.00 to $5.00 out of every $10.00 on your Evergreens. Get your Evergreens when you want them, direct from the grower, at low grower's net prices, delivered fresh, properly grown, dug, handled and packed, and guaranteed to be first-class by a guarantee you can depend upon.

We are a conscientious lot of workers here at Dundee. We give our brain, brawn and muscle to evergreen growing. We know from experience that there is only one way to grow and handle evergreens successfully—the Hill way. That's why Hill's Evergreens grow, why they invariably give satisfaction. We believe in what we have to sell and we value our reputation too highly to jeopardize it in any way.

Complete planting instructions and cultural directions furnished free with each shipment.

Hill Evergreens packed ready for shipment

THE NORWAY SPRUCE

HILL'S BEST EVERGREEN FOR WINDBREAKS

A sure, fast grower—bushy—transplants easily—absolutely hardy
Unqualifiedly "THE LEADER" for windbreaks

The popularity of the Norway Spruce throughout the United States is due to its extreme hardiness, rapidity of growth, sureness of growing after transplanting, and great usefulness as a windbreak, shelterbelt or screen.

D. HILL SAYS: "If I were asked what variety of Evergreen is best for general windbreak planting I would say unhesitatingly THE NORWAY SPRUCE. It has stood the test of time. I have tested it out and watched it grow year after year in all parts of the country. Norway Spruce windbreaks that I sold over fifty years ago are still giving service, growing steadily and satisfactorily and saving and making big money for their owners each year. I cannot add stronger testimony as to its worth than to say that I use Norway Spruce exclusively for windbreak on my own farms."

Single Specimen of Norway Spruce

It admirably adapts itself to all conditions and combines practical usefulness with ornamentation wherever used. Its dense growth forms an almost impenetrable barrier to the sharp, cold winds and frosts that are so damaging to stock and crops. Many fruit orchards are protected from the icy blasts from the north by rows of Norway Spruce along the boundary lines.

So valuable have they become, both in winter and summer, as conservers of vitality and strength to cattle and crops alike, that many farmers estimate an increased value of at least 25 per cent having been added by the planting of this Spruce for windbreaks and shelters.

For planting along line fences, between fields, walks, borders, drives and around orchards, vegetable gardens, about barns, stock shelters, pig pens, poultry runs, apiaries, the rapid growth and masses of dense foliage of this Evergreen forms a quick and permanent shelter during winter and summer that is unequaled.

Price, transplants	**Each**	10	10
12 to 18 inches	$0.20	$1.50	$ 6
18 to 24 inches	.35	2.25	12.
2 to 3 feet	.45	3.00	20.

5 of same size at 10 rate.
50 of same size at 100 rate.

A single row Norway Spruce Windbreak. Although comparatively young, this Windbrea

The Norway Spruce

Equally Valuable for Hedges, Screens, Etc.

For the purpose of Hedges and Screens, Norway Spruce is unexcelled. It responds readily to trimming and makes a beautiful, compact, hardy hedge for planting along drives and around the lawn, also as a border for dividing lots. Used as a screen it serves the double purpose of shutting off unsightly views and acting as a barrier to severe winds and storms.

Read What the Agricultural Experiment Stations Say:

ILLINOIS—Norway Spruce is one of the best Evergreens for windbreaks for this state.—Experimental Station, Urbana, Ill.

IOWA—Very valuable, an excellent grower, hardy, easy to handle, an all-around satisfactory tree.—Experimental Station, Ames, Iowa.

MASSACHUSETTS—The Norway Spruce is hardy and satisfactory here.—Agricultural College, Amherst, Mass.

MISSOURI—Norway Spruce is a sure grower and entirely reliable.—State University, Columbia, Mo.

MICHIGAN—Varieties best suited for this state are Norway Spruce, White Pine, Jack Pine.—J. Fred Baker, Experiment Station, East Lansing, Mich.

WISCONSIN—Norway Spruce, White Pine and Jack Pine are the best species for this state.—E. M. Griffith, State Forester, Madison, Wis.

NEW YORK—"The Norway Spruce is of rapid growth and is a graceful, handsome tree with dense foliage. It is one of the best conifers for windbreaks and shelterbelts."—L. H. Bailey, Cornell University, Ithaca, N. Y.

PENNSYLVANIA—"The Norway Spruce is an excellent conifer for windbreaks and shelterbelts and is hardy all over the state."—Experiment Station, State College, Pa.

OHIO—The Norway Spruce is well adapted to this state.—Ohio Agricultural Experiment Station, Wooster, Ohio.

MINNESOTA—Norway Spruce do well anywhere in the state.—University of Minnesota, St. Paul, Minn.

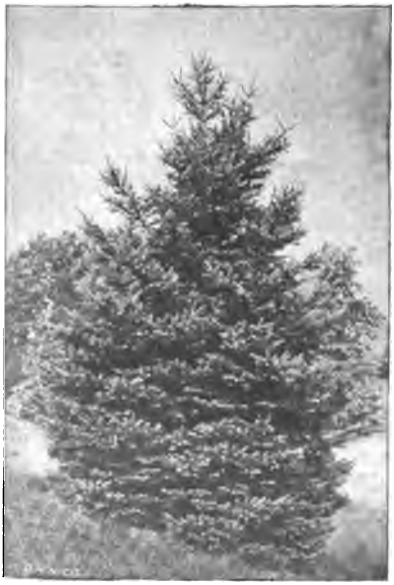
Norway Spruce is very stately and vigorous

Hill Norway Spruce Windbreak protecting house, garden and feed lot. See young windbreak started to left to protect barn. This farmer believes in Evergreen Windbreaks. He has three of them on his farm and has ordered another for this Spring—all Hill st

Black Hill Spruce Windbreak in Iowa. It is an acknowledged fact that windbreaks conserve moisture and make bigger crops

Black Hill Spruce

A Valuable, Noteworthy Tree



Black Hill Spruce

A Splendid Variety for the Western States Where a Tree is Needed that Will Endure the Hot Sun and Drying Winds of Summer and Give Protection from Cold Winter Winds and Storms.

This is a form of the White Spruce which has but recently been introduced into cultivation. It is a native of the Black Hills country of South Dakota and is proving to be an extremely valuable evergreen for the prairie planter. It possesses a well developed root system, is easily handled and is very hardy and quite resistant to drought and the drying influence of winter winds. It has already been planted to a considerable extent in some of the most trying sections of northern and western Iowa and for these sections has proved to be one of the most valuable evergreens for general planting. It is more easy to transplant and promises to occupy a prominent place in all future plantings. Botanically it is merely a variety of the White Spruce of the East, a modification probably due to environment.

In form it is more compact than the White Spruce and its foliage possesses less of the glaucous tinge and the needles are heavier and more prominent. It is not quite as rapid a grower while young as the true White Spruce.

The Black Hills Spruce as a tree for shelter-belts and commercial planting deserves a high rating and in a comparatively short period of time has made a definite place for itself in the commercial list. In the territory from Cherokee west and on the Missouri River bluffs it is one of the most successful evergreens.

Even the little fellows are stocky and compact. For ornamental plantings its attractive foliage makes it extremely valuable for park and lawn planting, which in addition to its longevity and ease of culture surely entitles it to a position among the leaders. For windbreak

Black Hill Spruce

prairie planting, in the states of South Dakota, Minnesota, Nebraska, Kansas, etc., and when planted in rich soil with favorable weather conditions its growth is wonderfully strong, rugged and luxurious. Seldom if ever has a new variety sprung so quickly into favor and popularity as the Black Hill Spruce. Its many sterling qualities proclaim it preeminently the tree of the future. For general planting Black Hill Spruce is worthy of the strongest endorsement. The trees are perfectly hardy and the foliage is unusually thick. It has already taken a place in the front rank as a truly remarkable tree well suited to our varying climatic needs. Plant liberally of this splendid variety and you will never regret it. It grows to large size, finally reaching a height of 75 to 100 feet. Moderately fast grower.

SOUTH DAKOTA—The Black Hill Spruce has no superior for hardiness and utility. Valuable for windbreaks and all farm plantings. Grows compact, uniform, uninjured by droughts, transplants readily, and deserves of being largely planted.—Agricultural Experiment Station, Brookings, S. D.

IOWA—A valuable tree for Iowa.—A. T. Irwin, Department of Horticulture, Ames, Ia.

MINNESOTA—A most valuable tree and succeeds well anywhere in the state.—E. G. Cheyney, University Farm, St. Paul, Minn.

Price, transplants	**Each**	**10**	**100**
6 to 10 inches......	$0.20	$1.00	$ 6.00
10 to 12 inches......	.25	1.50	9.00
12 to 18 inches......	.30	2.25	15.00

The Beauty of Spruce Trees in Winter

Valuable Everywhere

"No matter where you are located—north, east or west—you will find in Black Hill Spruce a tree of rare value. For Windbreaks it is at the top of the list, hardy, perfect in shape—compact and **windproof.** To appreciate its value one must see it as it grows in its natural range."—D. HILL, President.

5 of same size at 10 rate; 50 of same size at 100 rate.

This windbreak surrounds orchard and vegetable garden. It more than paid for its cost the first year. The owner says: "My evergreens are worth $2,000 to my place"

A Block of Blue Spruce Trees in Hill Nursery

View of small section of a block of Blue Spruce. Note grand silvery color, symmetry nd sturdiness. The grandeur of this stately mountain variety will transform your home rounds.

Colorado Blue Spruce

A Gem of the Rockies
Glistening Silvery Blue in Color
Absolutely Perfect in Form and Hardiness

Other trees there are of almost every imaginable color and form, but here is ruly the culmination of nature's highest effort to produce the beautiful. Picture n your mind a perfectly shaped tree, with an abundance of heavy foliage of a rich listening blue, which flashes and sparkles in the sunlight, and you can form only faint idea of the magnificent beauty of this truly marvelous tree. The glory of

Colorado Blue Spruce
Splendid for grouping with dark foliaged trees in background—gives superb contrast

King of Spruces

"The Colorado Blue Spruce, with its peculiar and lustrous bloom, is like a rare flower in itself. Clothed in royal robes of silver and sapphire, in shape a glistening pyramid of mingled beauty and stateliness, it is the joy of the beholder, the delight of the owner." —D. HILL.

"I have known $100.00 to be refused for a single tree. It is a child of the storm king, growing at an altitude of 8,000 to 10,000 feet above sea level. A very Kohinoor among the gems of the Rockies."—C. S. HARRISON, York, Nebraska.

"Enclosed find photograph of one of the Colorado Blue Spruces. I have two of these trees which I purchased from you nine (9) years ago for $5.00 each. A year ago I refused $100.00 each for them. Does it pay to grow Evergreens? Well, I am only sorry I did not plant my whole 5 acres to them."—J. H. ELLIS, Edgewater, Colorado.

Splendid Evergreen planting. Blue Spruce, Firs, Pines, etc.

Colorado Blue Spruce

Grows Successfully Everywhere

The Flashing Brilliancy of its Steel Blue Foliage is Unsurpassed. Absolutely Hardy —Transplants Easily. Thrives north—east—south and west

the Blue Spruce is in its foliage, which is an intense steel-blue. It is difficult to form an idea of the beauty and immensity of this phenomenal tree. It has created a great sensation throughout the United States and Europe and is indeed a triumph in evergreen growing.

As we have specialized in this variety for many years, we have succeeded in building up a magnificent stock (without doubt the largest in the world), and in walking through out Nurseries one sees block after block of these wonderful trees in all sizes and stages of growth, all being perfect in form and color, which annually attract many visitors from all over the country.

Don't miss purchasing one of these trees. There is a genuine treat in store for everyone who plants this variety, for it is difficult to form an idea of its beauty and attractiveness until you have seen it. This variety needs no petting or protection as they are absolutely hardy everywhere. No shearing or trimming is required—the natural habit is to grow to a conical shape. Group several trees in the corner of the lawn and watch them grow. Allow passages between the trees for best effect. They also show up well at entrances and along paths and drives. The growth is upright, bold, solid and massive, making a splendid lawn decoration. We recommend it without reserve. It should be planted about every home in every state in the Union and everywhere will it give satisfaction.

SAYS D. HILL: "Plant liberally of this tree and you will never regret it. I have yet to see a place where it will not grow successfully, and I have been shipping it to every state in the Union ever since first introduced from the Rocky Mountains of Colorado."

Price, transplants	Each	10	100
6 to 8 inches	$0.15	$1.25	$10.00
8 to 10 inches	.20	1.50	12.00
10 to 12 inches	.25	1.85	15.00

5 of same size at 10 rate.

50 of same size at 100 rate.

Note: Owing to the increasing demand for larger sizes, we have grown on a number which we offer as below in sizes up to six feet. All perfect specimens, both in shape and color. Each tree will be dug with large ball of earth, carefully burlapped and properly boxed.

Price, specimens	Each	Pair
2 to 3 feet, B. & B.	$3.00	$ 5.50
3 to 4 feet, B. & B.	3.75	7.00
4 to 5 feet, B. & B.	5.75	11.00
5 to 6 feet, B. & B.	6.50	12.50

Hemlock

The Best and Most Ornamental of all Hardy Evergreens

The choicest and most beautiful of all evergreens, absolutely hardy. Its delicate fern-like foliage is superb. Satisfactory planted either alone or in groups with other trees.

Hemlock, fine for Ornamental, Lawn and Garden Planting. Compactness Obtained by Shearing

A beautiful Evergreen of graceful habit and unequaled for ornamental planting, but on account of the enormous demand the last few years has become quite scarce. For garden, lawn or park planting, this variety stands out as one of the best. Attractive at all seasons of the year, especially in the spring and summer, when the new growth comes forth a delicate light green, soft and fern-like. It is one of the few Evergreens which thrive in a partial shade. Excellent for hedges, responding readily to shearing and can be kept to any desired height or form.

Although the illustration herewith shows something of its magnificent form, no photographic reproduction could do justice to its beautiful foliage. While shearing is not necessary, if done judiciously it will grow much bushier and stronger. This tree is entirely distinct and altogether unlike any other species. It is splendidly adapted for general planting and deserves a place on every lawn in America.

Hemlock

A Grand Native Evergreen Unsurpassed for Rich Beauty

We have Tested it Thoroughly and Recommend It Highly.

Hemlock is bright and cheerful the year round

The Hemlock surely takes first place as a truly remarkable Evergreen tree, having few equals as yard or lawn specimens, and for groups where rich, dark green foliage is wanted, nothing can excel it. Hemlock quickly adapts itself to a wide range of soil and climatic conditions. From the first we have always regarded this variety as one of the leaders and as our friends become better acquainted with it they join us in our admiration of its exquisite form and delicate beauty. It is certainly one of the most charming varieties of the whole Evergreen family, and is now widely used throughout the United States in all ornamental lawn plantings. It has been known to attain a height of 70 feet, but more often they average twenty-five to thirty feet in height.

Being an entirely distinct variety it is unlike any other species and its man
sterling qualities, including moderate growth, longevity, hardiness, adaptability t
shearing, compact conical shape and graceful appearance, lead us to endorse it i
most enthusiastic terms. Plant liberally of this charming variety and you wi
never regret it.

Price, transplants	Each	10	10
3 to 6 inches	$0.10	$0.75	$ 4.0
6 to 10 inches	.20	1.50	12.0
10 to 12 inches	.25	2.25	18.0
12 to 18 inches	.30	2.75	25.0

5 of same size at 10 rate; 50 of same size at 100 rate.

[illegible] for beauty and usefulness

White Pine Windbreak

This Windbreak protects barns, garden, feed pasture and chicken house. Every summer I try to visit as many of my customers as possible and look over their Windbreaks. When I called on this Ohio customer, he said to me: "Mr. Hill, I am proud of my Evergreen Windbreak and am glad you called so I can thank you. They have made my place the best known farm in this locality."

White Pine

King of the Forest

Thoroughly satisfactory for Iowa, Minnesota and all states east of the Mississippi. The ONE best pine for all New England States. Rapid grower, long lived. Makes perfect Windbreaks, Shelterbelts, Screens, Woodlots

The White Pine is without question the best all around tree of the entire Pine family, for planting in the states east of the Mississippi. On account of its rapid growth, value as windbreak, shelterbelt and screen, varied uses on the farm, and ease of planting, this tree is the most successful conifer of the northern and eastern states. It is not fastidious in its requirements and grows under the greatest variety of climate and soil conditions.

As a windbreak, White Pine has no superior. It grows thick and compact, forming an absolute barrier to winds and storms. Being a rapid grower, it soon gives good protection. It is thoroughly hardy and is impervious alike to extremes of heat or cold.

ILLINOIS—"Its rapid growth demonstrates that this tree can be successfully grown on prairie soil. It grows better in Illinois than any other pine and makes excellent shelterbelts."
State Agricultural College,
Urbana, Ill.

NEW HAMPSHIRE—"There is absolutely no question about the importance of White Pine in New Hampshire as a windbreak. I always recommend this species for planting where a person is in doubt as to what should be used."
Agric. Exp. Sta.,
Durham, N. H.

MICHIGAN—"White Pine stands first among the pines of the eastern United States for windbreak purposes. It is easily propagated and grows on a wide variety of soils. It is hardy throughout the entire state, and grows rapidly."
Michigan Agric. College,
East Lansing, Mich.

IOWA—"Native to Iowa. Succeeds well on all classes of soil. Has high value for windbreaks."
Agricultural Experiment Station,
Ames, Iowa.

NEW YORK——"Rapid grower. Hardy. Best for windbreaks. Reaches best development in region of Great Lakes. Most important conifer of the United States." Prof. John Gifford, Cornell University,
Ithaca, N. Y.

Utility and Beauty Are Combined in This Planting of White Pine

White Pine

Rapid Grower. Long Lived. Does Well Everywhere. Makes Perfect Windbreaks, Shelterbelts or Screens. A Big Money Saver for Stock or Grain Farmers, Orchardists, Poultrymen, Beekeepers

A noted Horticulturist in writing about White Pine says: "In the economy of kind ovidence the White Pine stands in the front rank among our benefactors. The wonder that men do not surround themselves with these faithful sentinels, which in great mies would stand guard around their homes, defending them from the fierce storms d icy blasts.

"Take a home on a bleak, windswept plain with no protection and it is a picture of solation. It is bombarded by the storms and the snows swirl around it. There is the rn out there in the open. Turn the stock out to water when the cutting north wind is low zero and they stand shivering as they drink. The terrible cold eats their flesh ay. To them winter is a martyrdom.

"This can all be eliminated by the use of an Evergreen Windbreak, for which White ne is best suited. I have noted, when the hot winds raged, that while fields of corn the open were burned up in August, those places sheltered by Evergreen Windbreaks duced good crops. Here, then, are your groves, shelterbelts and Evergreen enclosures. h year gives you protection and comfort till it seems that your home has been ved several hundred miles to the south."

MASSACHUSETTS—"The White Pine is our most uable tree for windbreaks, and thrives admirably all parts of the state. In this vicinity a tract White Pine between six and seven acres has been l within two years for $4,800.00."

Massachusetts Agric. Exp. Sta.,
Amherst, Mass.

OHIO—"White Pine is our best Evergreen for dbreak planting and grows well throughout the e. It is a hardy and rapid grower."

Edmund Secrest, State Forester,
Wooster, Ohio.

CONNECTICUT—"White Pine is native in this e and grows well in many different soils. It is adapted to light, sandy, glacial soils, which pre- in many parts of the state. In my opinion it nises the best results for windbreak purpose."

Agricultural Exp. Sta.,
New Haven, Conn.

WISCONSIN—"White Pine is a native of Wis- n. It is entirely hardy, and can be grown in section of the state."

University of Wisconsin,
Madison, Wis.

MINNESOTA—"White Pine is one of the fastest ing and the most useful of Evergreens for break planting. It is a magnificent tree."

University of Minnesota,
St. Paul, Minn.

Price, transplants	Each	10	100
o 12 inches.............	$0.20	$1.50	$ 5.00
o 18 inches.............	.30	2.25	9.00

Scotch Pine

A Great Tree for Windbreaks. Excellent for the West and Northwest
Thoroughly Reliable

As the name indicates this Evergreen is a native of Europe and Asia. In some states, notably Iowa, it is the most widely planted Evergreen today, and because of its hardiness and rapidity of growth has proved of much value in giving quick protection, which was so much needed about homes and farms in treeless regions. This variety is rather attractive in form and possesses a splendid root system. In the hands of the amateur it is perhaps the easiest of all Evergreens to transplant, and the rapid growth it makes from the very start gives it a combination of desirable qualities for the planter. This variety grows well on almost any soils.

OHIO—The Scotch Pine stands heavy soils and seems to grow well throughout the state.—Ohio Agricultural Experiment Station, Wooster, Ohio.

IOWA—The Scotch Pine and Norway Spruce are probably the most widely planted varieties in this state, primarily because easy to handle and fast growers.—Iowa State Agricultural College, Ames, Iowa.

Scotch Pine

KANSAS—The Scotch Pine has the ability to endure long continued heat and drouth and grows well all over the state.—J. W. Riggs, Experiment Grounds, Waterloo, Kansas.

MASSACHUSETTS—Scotch Pine is entirely hardy and satisfactory here.—F. A. Waugh, Massachusetts Agricultural College, Amherst, Mass.

OKLAHOMA—The Evergreens that have given best satisfaction with us are the Scotch, Austrian and White Pines and Red Cedar.—N. O. Booth, Oklahoma Agricultural Experiment Station, Stillwater, Okla.

NEBRASKA—The Scotch Pine thrives splendidly in eastern Nebraska and the sand hills.—Department of Forestry, Lincoln, Neb.

MINNESOTA—The Scotch Pine does well here.—University Farm, St. Paul, Minn.

Price, transplants	Each	10	100
12 to 18 inches	$0.25	$1.50	$ 7.50
18 to 24 inches	.30	1.85	9.00
2 to 3 feet	.35	2.25	11.50

5 of same size at 10 rate; 50 of same size at 100 rate.

Scotch Pine Windbreak

This Windbreak protects a huge barn in the foreground not shown in picture. In conversation with the owner, who entertained me at his home last summer, he said: "I consider that Windbreak the best profit maker on my farm."

Scotch Pine

A Fast Growing Evergreen. Best of all Pioneer Windbreak Trees. Very Ornamental. Does not Injure Crops. Grows Rapidly on Sandy Soils

This is one of the hardiest of Evergreens. It has been planted more than any other variety on the cold prairies of our north and northwestern states, where it thrives with immense success. Good results are attained by mixing it with other varieties of Evergreens for windbreaks, shelter belts and screens. It is one of the fastest growing Evergreens we have, often growing 3 feet in a single season, and soon obtaining large size. At maturity it reaches a height of 50 to 60 feet. In point of practical value it stands second only to the White Pine and is so well known that for many years it has been widely planted all over the country with unvarying success.

D. Hill says, "Scotch Pine is the best of all pioneer windbreak trees. It will stand extreme exposure and is very ornamental. In most places it has seemed to rival all other varieties in ability to stand hardships. It generally makes a growth of over 2 feet per year on an average as a young tree, and like other Evergreens does not injure the crops in its immediate vicinity."

VERMONT—Scotch Pine and Norway Pine are well adapted to this state. Plantings made with Scotch Pine have been very successful. On dry, sandy soils we find Scotch Pine grows more rapidly than any of the other pines.—Austin F. Hawes, State Forester, Burlington, Vermont.

NORTH DAKOTA—The Scotch Pine succeeds well, and we have seen it grown in a good many locations.—O. B. Waldron, Department Horticulture and Forestry, Agricultural College, N. D.

MONTANA—From general observation both here at Bozeman and other points, I would say that the best pines for windbreak purposes in Montana are the Scotch and Austrian Pine. They both seem to do well and make rapid growth.—Experimental Station, Bozeman, Montana.

COLORADO—We are trying out a number of Evergreen species foreign to the state, such as Scotch Pine, Red Cedar, Arbor Vitae, Black Hill Spruce and Austrian Pine. Of these the most successful thus far has proven to be the Scotch Pine.—State Agricultural College, Fort Collins, Colorado.

Old Scotch Pine

A planting of Hill's Evergreens in Iowa. Note Windbreak, Hedge and Lawn Trees

Austrian Pine

Hardy, Rapid Grower, Long Lived. Excellent for Windbreaks

MISSOURI—"The Austrian Pine thrives splendidly in Missouri. It is perfectly hardy and is not injured by the long droughts that we sometimes have. I have never known it to winter-kill. It will reach a very old age and it is one of the best evergreens for this state."—W. L. Howard, University of Missouri, Columbia, Mo.

MICHIGAN—"The Austrian Pine, introduced from Europe, has been widely planted over the northern part of the United States for many years. It has proven itself entirely hardy in Michigan, where old trees are found with great frequency in dooryards, cemeteries, parks and public grounds. It has a very rugged habit of growth which gives it extra value for certain kinds of ornamental planting."—Michigan Agricultural College, East Lansing, Mich.

IOWA—"This variety is extensively planted here and invariably gives good results. Fully as hardy as the Scotch Pine and lives equally as long. It possesses a heavy, dark green foliage and is considered a superior variety for windbreaks and shelterbelts. It is rapid in growth."—Iowa State Agricultural College, Ames, Iowa.

OKLAHOMA—"I have had long experience in southern Kansas raising evergreens and I found that the Austrian Pine and Red Cedar were the best trees for the prairie sections of all those tested."—N. O. Booth, Oklahoma Agricultural Experiment Station, Stillwater, Okla.

This valuable tree, although of comparatively recent origin, has gradually worked its way into favor until today it is one of the most well known and widely planted evergreens on the list. In open positions a broad, bushy crown is produced which is very ornamental. Its strong, massive branches impart an air of sturdiness, making it a favorite for group planting. On account of its rapid growth and extreme hardiness, it is of inestimable value as windbreaks, shelter belts and screens. Its dense growth stops snow and wind and in a few years the trees grow to a size that renders excellent protection to stock, crops and buildings.

Price, transplants	Each	10	100
6 to 12 inches	$0.25	$1.85	$ 9.00
12 to 18 inches	.30	2.25	12.00

5 of same size at 10 rate; 50 of same size at 100 rate.

Valuable variety for windbreaks and ornamental lawn planting. Famous both for utility and beauty of foliage. A Wonderful

Jack [illegible] used as timber block and windbreak. Grows well and stands long drought without injury

JACK PINE

Hardy—Endures Extremes of Heat or Cold. Very Desirable for Windbreaks, Groves, Shelterbelts and Screens. Grows where others Fail. Thrives on the Poorest of Soil

This variety is unquestionably well suited to the dry, hot climates and sandy soils of Kansas, Oklahoma, Texas, New Mexico, Nebraska and the Dakotas. Windbreaks of Jack Pine planted near Brookings, South Dakota, in 1908, have done remarkably well and are very vigorous and thrifty. In the sand hills of Nebraska its growth and success is phenomenal. Protection for stock and crops from the hot, parching winds of summer and the cold, dry winter winds is an absolute necessity in some states, and for this purpose Jack Pine cannot be excelled.

"Jack Pine makes a satisfactory growth on poorest, sandy soils and it must be considered as one of the best trees for such situations. It can be planted with success where most other species fail. It makes a serviceable windbreak and may be planted for the production of posts or saw timber. It is one of the most rapid growing pines, will stand considerable drought and is seldom injured by frost.

"I have known plantations which had been set out only four years to average in height eight or nine feet."—Prof. G. B. McDonald, Iowa State Experimental Station, Ames, Iowa.

PROF. S. B. GREEN of St. Paul, Minn., says: "This tree under favorable circumstances will occasionally attain a height of 125 feet, with a diameter of twelve inches. It makes a tremendous growth while young. A single acre will yield 40 to 50 cords of wood and a great deal of farming timber besides."

MICHIGAN—"Jack Pine is a native to Michigan and is well suited to the poor sands of the northern part of the state. On the so-called Jack Pine lands, and cut-over areas where the soil is too poor for other evergreens to thrive, Jack Pine has a place."—Michigan Agricultural College, East Lansing, Mich.

MINNESOTA—"The Jack Pine is the hardiest native evergreen we have and is especially adapted to dry, loose soil, where it has a wondrous power of withstanding drought. It is of rapid growth, which, together with its extreme hardiness, has led to its being planted extensively throughout dry, hot states of the West."—The University of Minnesota, St. Paul, Minn.

CANADA—"Jack Pine is found throughout the province of Manitoba on sandy soils and reaches its best development west of Lake Winnipeg. It flourishes on dry, sandy plains. The best Jack Pine timber produces a good grade of saw and tie material. It is coming more and more into use as pulp and may be found useful for paving blocks."—University of Ontario, Guelph, Ont., Canada.

JACK PINE
FOR
KANSAS and NEBRASKA

"The Jack Pine has long been recognized as a tree of inestimable value for the sand hill region of Kansas and Nebraska.

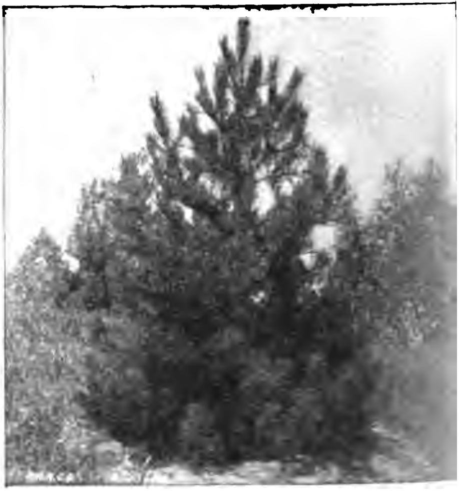
"Thousands of Jack Pine trees have been planted here within the last few years and according to the reports that I have secured from the planters the usual percentage of growth is about 80 per cent.

"I heartily recommend this tree for planting on dry, sandy soils and in hot climates such as we have here."—CHAS. A. SCOTT, State Forester, Manhattan, Kans.

Price, transplants	Each	10	100
12 to 18 inches			

Ponderosa Pine

Has Dense Foliage, Requires Little Space and Grows Well Without Cultivation



Ponderosa Pine

The Bull or Ponderosa Pine, also known as Western Yellow Pine, is native to the western United States, and is thoroughly suited for planting west of the Mississippi River.

Because of its dense foliage and ability to grow in close stands, it makes excellent windbreaks and shelter belts. A prominent horticulturist of South Dakota says: "I have a row of this tree on the top of a hill, now averaging about twenty feet high, straight and thrifty as a pine should be. Never have they showed a dead limb or lost their leader. If you consider it too much work to cultivate or even break the ground, just stick it out on the sod and if it starts the first season it will come on and make a good, thrifty tree, showing that it does mind droughty spells or sod-bound sites."

Price, transplants	**Each**	**10**	**100**
10 to 12 inches	$0.20	$1.50	$7.50
12 to 18 inches	.30	2.25	9.00

5 of same size at 10 rate; 50 of same size at 100 rate.

C. S. HARRISON

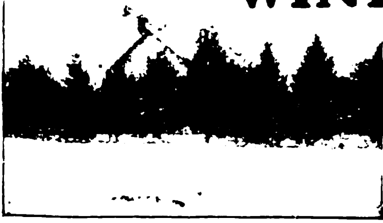
MR. C. S. HARRISON OF NEBRASKA SAYS:—"The Ponderosa Pine is one of the most rugged, robust and hardy of all the pine family. This tree belongs to Nebraska. It grows thriftily on the bare hills in the northwestern parts of the state. You will find it perching like the cliff dwellers, on high, barren bluffs where nothing else will grow. This tree must be our main reliance for the sand hills and is thoroughly reliable for the Dakotas, Minnesota, Kansas, Nebraska, Oklahoma, New Mexico, Colorado and Wyoming. It is native and will resist the extremes of heat and cold.

"The last time I went to the Black Hills, out on the plains, in a gorge, on a shelf of rock, with no vegetation around it, I saw a lone Ponderosa Pine. There it stood like an emblem of hope in the heart of desolation.

"One fall when it had been very dry and all the trees were turning yellow, I noticed some trees very green and vigorous. There was no water within 200 feet. Having occasion to dig near the ditch, I found the roots of these same trees had gone down to drink, like a herd of cattle, and there they were, pumping moisture into those trees 200 feet away."

WIND-BREAKS

SCREENS AND SHELTERS FOR COUNTRY HOMES



arf Mugho Pine. A grand dwarf variety from Switzerland. Fine lawn tree when planted in groups or singly. Its beauty is indescribable

)warf Mugho Pine

t of all Dwarf Trees. Rarely Grows Over Six Feet Tall. Fine for Low Borders, Beds or Singly. Absolutely Hardy Everywhere.

A variety truly superb. This beautiful e tree is not excelled by any when beauty, fulness and adaptability are considered. Its que habit of growth gives it a distinction popularity seldom possessed by any Ever- en. Rarely attaining a height of six feet , its branches curve outward then upward n the stem at the ground, often spreading ce as broad as it is tall. It looks entirely erent from all other evergreens. Its foliage f dark green color, the branches stiff and bby. They are indeed one of the most little evergreens we offer. Its native home n the mountains of Switzerland, from where obtain our seeds direct. Are especially pted for numerous purposes such as group nting, low borders, and individual specimen nting. Make up well with Junipers. Being fectly hardy they can be planted success- y in all sections of the country. We advise cing early orders as our stock is rather ited.

rice, transplants	Each	10	100
o 8 inches............	$0.20	$1.50	$10.00
o 10 inches...........	.35	2.25	18.00

5 of same size at 10 rate.
50 of same size at 100 rate.

Dwarf Mugho Pine

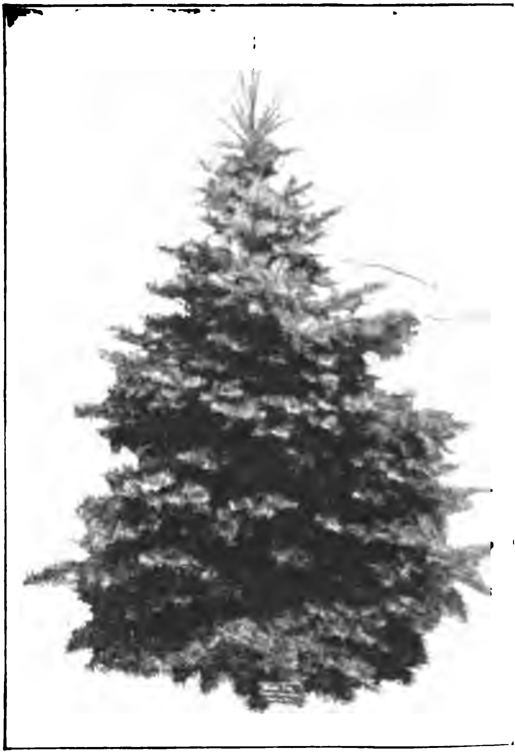
Dwarf Mugho Pine in border

Concolor Fir

Queen of the Firs

A Rocky Mountain Variety of Charming Beauty. A Native Tree of Exceptional Merit and Absolute Hardiness. Plant Liberally of This Tree and You Will Never Regret It.

A beautiful Evergreen from the Rocky Mountains, and in ornamental value second only to Blue Spruce. Its foliage is long, soft and graceful, varying in color from light green to deep, soft blue; it is entirely different from any other variety. Being a comparatively rapid grower, it soon matures into tall, broad specimens of magnificent beauty. It is, without doubt, the most successful of all Firs, and has become so widely known and appreciated that it is planted extensively throughout European countries, where it is very popular and much admired for its many sterling qualities. A tree perfectly hardy and long-lived, even in the most exposed situations, reaching at maturity a height from 60 to 80 feet. Beautiful effects are produced by planting a group of Concolor Fir, Blue Spruce and Douglas Fir, as their charming tints of blue and green contrast prettily and nothing could be more ornamental for lawns.



Concolor Fir Has Splendid Ornamental Foliage, a Hardy Constitution—Gives Satisfaction Everywhere

An eminent horticulturist writes of Concolor Fir as follows: "A singular thing about them is, though their native home is far inland and they thrive at a high altitude, they make one of the finest coast trees that can be secured. While the sheen of other trees will fade with passing years, these retain their glory, keeping their attractiveness to the very last. In order to see these trees in all their glory you need to visit them while bearing their cones."

Price, transplants	Each	10	100
6 to 10 inches	$0.25	$1.50	$ 7.50
10 to 12 inches	.30	2.25	10.50

5 of same size at 10 rate; 50 of same size at 100 rate.

Splendid Evergreen planting. Refreshing and cheerful summer and winter

Balsam Fir

MOST FRAGRANT OF ALL EVERGREENS

A native American variety and a handsome tree of characteristic aspect. The bark on all but the very oldest trunks is abundantly supplied with rosin blisters which yield the Canada balsam of commerce. Thrives on bottom land and moist slopes. Quite hardy except with severe north exposure.

Mr. Thos. McAdam of New Jersey in a recent article says: "The Balsam Fir of the North is the most fragrant of all evergreens. The characteristic odor of far northern woods is chiefly, if not solely, due to this fir. The young growths are often used for making pillows. The best Christmas trees are also furnished by this species. Would that some hybridizer could get the fragrance of it into all our other evergreens."

Balsam Fir

Price, seedlings	10	100	1000
4 to 6 inches, 3 yr.	$0.50	$1.50	$9.00

5 at 10 rate; 50 at 100 rate; 500 at 1000 rate.

European Larch

FAST GROWING VALUABLE TIMBER TREE

European larch is preeminently the fastest growing variety known that has a high value as timber. It will grow if planted on good soil and well tended while small, nearly one inch in thickness each year of its growth. The practical value of this tree is certainly not overestimated. Notwithstanding its quick growth, its timber has been proven by actual tests to be more durable than a good many of the slow growing hardwoods. On account of the prominence given this variety by several of the leading agricultural papers, not only have thousands of small groves or woodlots of one or more acres in extent been established, but many large commercial plantations have been planted out.

Larch is known from the Atlantic to the Pacific and for a practical tree for all purposes it is unsurpassed. When grown singly and planted on lawns, parks, public grounds or avenues, few trees are so majestic and imposing. This interesting tree admits of striking landscape results on account of the graceful feathery foliage with its soft tones of green, fading and falling in the autumn with tones of deep yellow and bronze. Contrasted against the somber green of taller evergreens it is remarkably beautiful. Truly a beautiful tree.

Price, transplants	Each	10	100
18 to 24 inches	$0.35	$2.50	$20.00

5 at 10 rate; 50 at 100 rate.

Larch Grove in Northern Minnesota. To date thinnings alone more than cover the original cost. It is now a source of constant annual income, supplying its owner and surrounding community with fence posts, firewood, timbers, etc.

Red Cedar

THE MOST REMARKABLE JUNIPER IN THE WORLD.

Botanically—Juniperus Virginiana, Platte River Variety

Red Cedar is the great American Juniper and certainly is worthy of the highest endorsement for general planting. It has been tested thoroughly in each and every state in the Union and has proven entirely satisfactory. Red Cedars are hardy, growing fast, thick, bushy, upright and tall like a column. The foliage is a beautiful light green in summer, turning to bronze in winter; rather soft in texture and takes a graceful habit of growth. In season it is covered with bright blue and silver colored berries which adhere to the branches a long time. Its foliage emits that pleasing, spicy, fragrant, woodsy, cedrus odor, so characteristic of Cedars and Junipers. Certain it is that its beautiful foliage and graceful form have attracted world-wide attention.

Red Cedar

It also has that which is of prime importance, a vigorous constitution, forming a tree of wonderful sturdiness, absolutely perfect in every particular, and our thorough trials lead us to endorse it in our most enthusiastic terms. It takes a place in the front rank as a remarkable variety suited in every particular to our varying climatic needs and withstands our coldest winters with impunity. This is truly a tree among trees, and the fact that we alone, after many years of experiments, have devised a process for successfully raising them from seeds, marks an important epoch in the tree world. Both the tree loving public and ourselves are to be congratulated that this grand variety is now procurable in sufficient quantity for general distribution and planting.

KANSAS—Red Cedar is a good tree for Kansas. Is perfectly hardy and makes a very satisfactory growth because it is well suited to Kansas conditions.—C. A. Scott, Kansas State Agricultural College, Manhattan, Kansas.

ILLINOIS—The small Red Cedars I planted three years ago have done wonderfully well. It is one of the best varieties on my place. Although not so fast growing as the Norway Spruce and

A splendid grove of Red Cedars in Iowa owned by proprietor of "Cedarhurst" Farm. Red Cedars grow successfully North, East, South and West

Red Cedar

White Pine, they make up for it in bushiness and robust appearance. I find that all Evergreens, especially the Red Cedars, are great attractors for birds and should be more extensively planted by farmers for this reason.—Cedarcrest Farm, Whiteside County, Illinois.

IOWA—The Red Cedar is a hardy, thrifty grower and does well in all parts of Iowa—and should be planted in increasing numbers. It thrives in all classes of soils, from dry uplands to swampy situations, and is of great value for general ornamental and windbreak planting. In Iowa it forms a rugged trunk with round, dense head, and reaches a height of 60 to 80 feet. An attractive feature of the tree is its bright bluish berries. A number of Red Cedars planted on the college campus at Ames, Iowa, from 1870 to 1880 are now broad, handsome specimens. Its hardiness, permanency and longevity commend it to a much more extensive planting than at present. The Red Cedar is also a very satisfactory hedge tree, as it responds to shearing readily.—Experiment Station, Ames, Iowa.

NEBRASKA—Red Cedar does well throughout the state and we recommend it highly.—W. J. Morrill, Dept. of Forestry, Lincoln, Nebraska.

MINNESOTA—About twenty years ago my brother and I bought one hundred Red Cedar trees, ranging from four to twelve inches high, for planting on our place in Kandiyoki County, Minn. We planted the trees a foot apart in one row. When we were finished they could hardly be seen on account of their small size. After cultivating three years we transplanted them to where they now set in a row on each side of the driveway, sixteen feet apart. The tree branches at the base are lying on the ground and they now measure nine feet, so that they overlap two feet.

We did not expect to see the day when these branches would shake hands, but in a year or two they will touch elbows. The trees average twenty feet in height. Not a branch of any of these trees has decayed. Plant the Red Cedar and you will make no mistake.—F. E. Danielson, Kandiyoki County, Minnesota.

Price, transplants	Each	10	100
4 to 6 inches	$0.15	$0.75	$ 6.00
6 to 10 inches	.25	1.00	8.00
10 to 12 inches	.30	1.50	10.00

5 of same size at 10 rate.
50 of same size at 100 rate.

Red Cedar is very stately and vigorous

Red Cedar makes excellent windbreaks. hedges and lawn trees. Respond readily to shear.

merican Arbor Vitaes will stand any amount of shearing, have beautiful foliage, hen make perfect hedges

American Arbor Vitae

The National Hedge of America

Hardy **Trims Well** **Good Foli**

Of all Hardy Evergreen hedge plants, the Ame can Arbor Vitae is without a rival and is a gene favorite everywhere.

Owing to its compact appearance when shea and its bright green color, it is without doubt best tree for hedge purpose that grows. Being p fectly hardy and of comparatively rapid growth forms a beautiful, compact hedge in a remarkal short time. It is preeminently a tree without equal for practical utility and orn mental value. There is not a law no matter of what proportion, whe an Arbor Vitae hedge would not e hance its beauty to a high degree, a serve at the same time as dividi lines, walk borders, or screen, etc.

No matter where you live, it w give you perfect satisfaction. It absolutely the finest and most wide used hedge plant in the world.

AMERICAN ARBOR VITAE

The National Hedge of America

SAYS D. HILL:—"The value of this tree can not be over estimated nor can it be too largely used. It is a tree without equal for hedge planting."

AMERICAN ARBOR VITÆ

Best Tree for General Planting in Existence

No Evergreen, either native or introduced, will endure so much hardship and grow on so great a variety of soils as the American Arbor Vitae. We have the largest and finest stock of this variety in the country and guarantee our trees to be absolutely first-class in every particular. We have featured this noteworthy variety for many years, becoming expert in its propagation, until Hill's American Arbor Vitae are now acknowledged to be the finest procurable. They have that which is of prime importance—a hardy, vigorous constitution, with an abundance of strong, healthy, fibrous roots.

FOR HEDGE PURPOSES it is unsurpassed. Owing to its compact appearance when sheared and its bright green color, it is without doubt the best tree for hedge purposes that grows. Being perfectly hardy and of comparatively rapid growth, it forms a beautiful, compact hedge in a remarkably short time. It is preeminently a tree without an equal for practical utility and ornamental value. There is not a lawn, no matter of what proportion, where an Arbor Vitae hedge would not enhance its beauty to a high degree.

FOR GROUP PLANTING it is unexcelled, and when planted in this manner it grows tall, stately and pyramidal, its beautiful, flat, fern-like foliage overlapping each other, forming splendid, symmetrical specimens unsurpassed for rich beauty. The permanent attractiveness of one's home surroundings is undeniably incomplete without a group of these charming trees, which, growing tall and well formed, become more beautiful each year.

WINDBREAKS, SHELTERBELTS AND SCREENS.—For practical purposes such as windbreaks for stock pastures, poultry yards, orchards, gardens and buildings, it is rapidly becoming more popular each year. By planting quite close together, as in illustration, their branches interlock closely, forming a barricade through which cold, piercing winds cannot penetrate.

Price, transplants	Each	10	100
3 to 6 inches	$0.05	$0.35	$2.50
6 to 10 inches	.10	.75	5.00
10 to 12 inches	.15	1.00	7.00
12 to 15 inches	.20	1.85	12.00

5 of same size at 10 rate.
50 of same size at 100 rate.

American Arbor Vitae

Fine for Ornamental Lawn Planting

Norway Pine

Very Hardy and of Rapid Growth

Like the White Pine, this variety grows well on sandy soils where the moisture supply is limited. It closely resembles the Austrian Pine, the foliage, however, is darker green and not quite so stiff. The bark has a reddish tinge. It has been planted quite extensively for some years and we can recommend it highly for ornamental lawn planting, groups, windbreaks and wood lots.

NEW HAMPSHIRE—In my opinion Norway Pine is superior to all other varieties of pines. It grows on poor soil, is free from injury, exceedingly sturdy and grows rapidly.—J. H. Foster, New Hampshire Agricultural Experiment Station, Durham, N. H.

Norway Pine is well adapted for lawn planting

Price, transplants	Each	10	100
10 to 12 inches........	$0.35	$2.25	$9.00

5 at 10 rate; 50 at 100 rate.

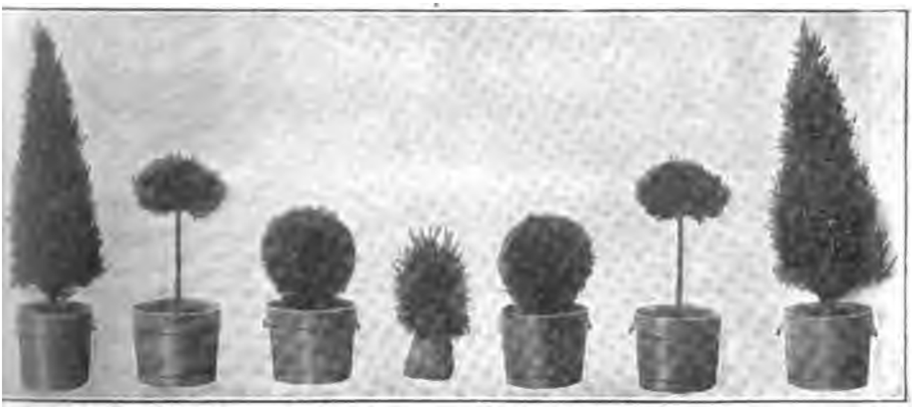
American Yew

A Superb Native Variety

This magnificent tree is one of the grandest, hardiest Yews in existence. It is undoubtedly one of the most distinct and valuable varieties of the entire family. It is to America what the grand old English Yews are to England, the national tree. Although growing very slowly, it possesses a peculiar tint in the color of its foliage, so far unapproached by any other variety. It is admired for its appropriateness in parks and cemeteries, but especially is it popular for small lawns and dooryards where space is limited. The foliage is a deep, dark, verdant green, with a peculiar richness and a certain stiff formality of growth that pleases the taste of everyone. It grows splendidly in shady locations, such as the north side of a building or under other trees.

The Yews are proverbially long lived and instances are given where they have existed for centuries. In size this remarkable tree rarely grows over five feet high and about twice as broad. In season it is covered with bright red edible berries which contrast very prettily with its dark green foliage. Although difficult to propagate, their culture is easy. The available supply is always limited.

Price, transplants	**Each**	10



Pyramid **Standard** **Ball Shaped** **Bush** **Ball Shaped** **Standard** **Pyramid**

Boxwood

ake Ideal Decorations For Porches, Terraces, Walks, Driveways, Entrances

This variety is so popular as to hardly need escription. It has always been and still is ssentially a home plant. The glossy aromatic oliage is always fresh and green. The tubbed pecimens are widely used for porches, teraces, walks, driveways, entrances and formal ardens. All the various forms are compact.

BOXWOOOD PYRAMIDS. Excellent pecimens trained to perfect pyramids.

Price	Each	Pair
feet, tubbed	$3.50	$6.00
feet, tubbed	4.50	7.50
feet, tubbed	5.00	9.00
feet, tubbed	6.75	12.00

BOXWOOD STANDARDS. Straight stems ith symmetrical globular crowns.

Price	Each	Pair
to 18 inch stems, 15 to 18 inch crowns, tubbed	$3.75	$ 7.00
to 36 inch stems, 15 to 18 inch crowns, tubbed	6.75	12.75

BOXWOOD BALL SHAPED, clipped solid. losely clipped specimens of globular form, itable for vases, urns, etc.

Price	Each	Pair
inch, tubbed	$3.75	$7.00
inch, tubbed	4.25	9.25
inch, tubbed	5.50	10.50

BOXWOOD BUSHES. Suitable for borders, dges and window-box planting. May be eared into various forms.

Price	Each	10
to 12 inch	$0.50	$ 3.75
15 inch	.75	5.50
18 inch	.90	7.50
24 inch	1.20	11.25
30 inch	2.25	18.75

BOXWOOD DWARF EDGING. Used exnsively for bordering walks and very popur for edging porch and window boxes.

Price	Each	10	100
to 6 inches	$0.25	$1.50	$11.25

f same size at 10 rate. 50 of same size at 100 rate.

Boxwood Pyramid

HILL'S EVERGREEN BOOK

Evergreen Seedling Beds, European Larch at left; Scotch Pine in center; One-year White Pine under racks at right

Hill's Evergreen Seedlings

All Hardy Sorts, Strong, Thrifty and Well-Rooted. Will be Graded and Tied in Bunches of 50 an 100. 50 at 100 Rate; 500 at 1000 Rate. Write for Special Prices on Larger Quantities

We have specialized in the growing of Seedlings for over half a century and hav the largest and most complete stock in America. We have every facility for growin from seed—plus the finest natural location in the United States—plus over fifty years practical knowledge of how to do it best. We are growing millions annually. We g to a great deal of expense gathering and sowing our seed, but we think it's worth i all to know that the little trees are true to name, healthy and vigorous. (See illustration.)

To obtain best results Evergreen Seedlings should not be planted where wanted permanently at once, but should be bedded out in garden under shade for one year, in a choice, well protected spot, where they can be watered and cultivated and weeded. Plant in rows, four feet long, two inches apart in the row and the rows six inches apart. Shade the first season with lath frames or brush. At the end of the first year they will have developed sufficient fibrous roots so they will be ready to set out where wanted permanently. Great care should be taken to have the ground in proper condition for planting. Spade it deep, rake it fine and level and afterward see that the trees are tramped firmly into the soil.

Dear Sir: Out of the 1,500 seedlings I bought of you last spring I lost only a few and will want a larger order next

and weeding Evergreen Seedlings—allowing only the seedling trees to absorb plant food and moisture from the soil

HILL'S EVERGREEN SEEDLINGS

	Size	Age	100	1,000
alsam Fir	4 to 6 inch	3 yr.	$1.50	$ 9.00
emlock	3 to 6 inch	3 yr.	3.00	18.00
ncolor Fir	3 to 5 inch	2 yr.	1.50	10.50
ncolor Fir	4 to 8 inch	3 yr.	2.50	13.50
ouglas Fir	3 to 6 inch	2 yr.	1.50	6.00
ouglas Fir	6 to 10 inch	3 yr.	1.85	7.50
ed Cedar	2 to 4 inch	1 yr.	1.50	9.00
ed Cedar	6 to 10 inch	2 yr.	3.00	18.00
uropean Larch	4 to 8 inch	2 yr.	1.50	7.50
merican White Spruce	4 to 8 inch	3 yr.	2.25	10.50
merican White Spruce	6 to 12 inch	4 yr.	2.50	13.50
lack Hill Spruce	3 to 6 inch	4 yr.	2.50	10.50
nglemann Spruce	3 to 6 inch	3 yr.	2.25	7.50
orway Spruce	2 to 5 inch	2 yr.	1.50	3.75
orway Spruce	3 to 6 inch	3 yr.	1.85	5.25
orway Spruce	6 to 10 inch	4 yr.	2.25	7.50
olorado Blue Spruce	4 to 8 inch	3 yr.	2.25	9.00
ustrian Pine	3 to 6 inch	3 yr.	2.25	9.00
ck Pine	3 to 6 inch	2 yr.	1.50	3.75
ck Pine	6 to 12 inch	3 yr.	1.85	7.50
warf Mugho Pine	2 to 4 inch	2 yr.	1.50	6.75
warf Mugho Pine	4 to 8 inch	3 yr.	1.85	9.00
onderosa Pine	3 to 6 inch	2 yr.	1.50	4.50
onderosa Pine	6 to 12 inch	3 yr.	1.85	7.50
itch Pine	2 to 4 inch	2 yr.	1.50	6.75
hite Pine	3 to 6 inch	2 yr.	1.50	6.00
hite Pine	4 to 8 inch	3 yr.	1.85	7.50
otch Pine	2 to 5 inch	2 yr.	1.50	4.50
otch Pine	6 to 12 inch	3 yr.	1.85	7.00
cotch Pine	10 to 20 inch	4 yr.	2.25	9.00
merican Arbor Vitae	2 to 5 inch	2 yr.	1.50	10.50
merican Arbor Vitae	4 to 8 inch	3 yr.	2.25	15.00
hinese Arbor Vitae	4 to 8 inch	2 yr.	1.50	7.50

50 of same variety and size at 100 rate; 500 of same variety and size at 1,000 rate.

HILL'S DECIDUOUS SEEDLINGS

	Size	Age	100	1,000
oft Maple	6 to 12 inch	1 yr.	$1.50	$ 5.25
ard or Sugar Maple	4 to 8 inch	1 yr.	1.85	9.00
apanese Barberry	6 to 15 inch	2 yr.	1.50	12.00
merican Sweet Chestnut	6 to 12 inch	1 yr.	1.50	12.00
merican Sweet Chestnut	12 to 18 inch	2 yr.	2.25	15.00
atalpa Speciosa	6 to 12 inch	1 yr.	1.15	3.75
atalpa Speciosa	12 to 18 inch	1 yr.	1.50	5.25
hite Ash	12 to 18 inch	2 yr.	1.50	3.75
hite Ash	18 to 24 inch	2 yr.	1.85	5.25
hite Ash	24 to 36 inch	2 yr.	2.25	9.00
ild Red Cherry	8 to 12 inch	1 yr.	1.50	9.00
ild Black Cherry	8 to 18 inch	2 yr.	1.85	10.50
in Oak	6 to 10 inch	1 yr.	1.85	12.00
ed Oak	3 to 6 inch	1 yr.	1.85	9.00
ed Oak	12 to 24 inch	2 yr.	2.25	12.00
lack Locust	6 to 12 inch	1 yr.	1.25	3.00
lack Locust	12 to 18 inch	1 yr.	1.50	5.25
lack Locust	18 to 24 inch	1 yr.	1.75	6.00
merican Elm	12 to 24 inch	2 yr.	1.85	6.00

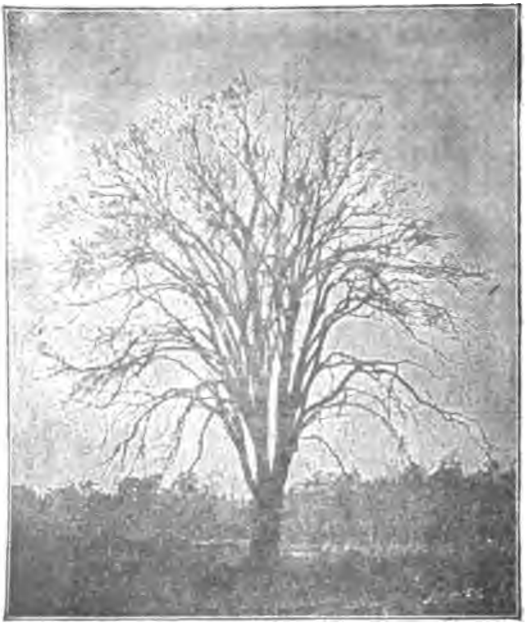
50 of same variety and size at 100 rate; 500 of same variety and size at 1,000 rate.

Orders for seedlings must call for at least 50 of any one variety.

American White Elms are beautiful trees for street planting

Hill's Deciduous Trees

This department includes trees of varieties which drop their leaves in winter. Their uses are manifold, the more important being the beautification of landscape, shade and shelter. No garden or landscape is complete without them. Plant a few of these on your lawn, dooryard or treebank, and you will be surprised how they will increase the value and beauty of your property. The trees offered below are all select, straight specimens and fully uphold the reputation of all "Hill Grown" stock.



Splendid Specimen of American White Elm taken in winter to show construction

AMERICAN WHITE ELM

A Good Shade Tree Fine for Treebank, Park and Boulevard Planting

Probably the most picturesque of all shade trees. The branches are thickly covered with leaves, but stand wide apart at the tops, making vase-like trees. In a few years Elms get quite high, and eventually they reach fully a hundred feet. A characteristic is that each tree is composed of two, three or four main trunks, brancing from the common roots, near the surface of the ground. Not all of the trees grow in this way, but most of them do, and those to whom Elms are a familiar sight come to look for the outcurving trunks as part of the landscape, a landmark, a distinguishing point of a homestead. The trees get finest in the shortest time when growing in moist loam, but they will grow anywhere We grow them for high class retail trade and have a complete supply of all sizes.

Price, transplants	Each	10	100
3 to 4 feet	$0.20	$1.50	$ 5.00
6 to 8 feet	.45	3.00	12.00

Maple Trees in Nursery; notice how straight and clean and how well branched

Norway Maple

For general use the finest shade tree in the world. We have yet to find a place where Norway Maples will not thrive, or to find any other tree so satisfactory in growth with such handsome foliage, such splendid rugged frame and trunk. In the nursery these Maples begin to form a round head above a straight, smooth trunk, and as they grow older the head becomes denser and rounder, and the limbs and trunk straight and strong. The branches grow straight horizontally, and the leaves are broad and very green.

They grow fast, their shape is graceful when they are ittle, and when they are old their foliage is beautiful, nd they are thoroughly dependable in all situations. Once stablished, Maples are good for two hundred years of the inest kind of shade.

Price, transplants	Each	10
to 6 feet	$0.35	$ 3.00
to 8 feet	.75	6.00
to 10 feet	1.25	10.00

SCHWEDLER'S PURPLE LEAF MAPLE

Another distinct variety of Maple. Has foliage of deep purple in early spring. This changes through the ummer and fall, first to bright light green, which it holds r weeks, and then to gold and red. Very beautiful.

Price, transplants	Each	10
to 8 feet	$1.25	$10.00
to 10 feet	2.25	18.50

5 at 10 rate.

Norway Maple

Norway Maples and Arbor Vitae Hedge. Don't you wish you had them?

Group your shrubs like this and they will show splendidly

Hill's Ornamental Flowering Shrubs

Whether your space is limited to a small yard or is a lawn of many acres, shrubs are indispensable. If you purchase your shrubs from us, you will get a succession of bloom from early spring till frost comes in the fall, together with beautiful color and form in the foliage and bright berries.

Spiræa Van Houttei

It is our aim to produce everything in Flowering Shrubs that is useful, hardy and worthy of general cultivation in our climate. We provide conditions which produce the highest quality in shrubs, which are grown with plenty of room to develop an abundance of fibrous roots and large, strong, healthy tops. In planting shrubs, prepare the ground as for a crop of potatoes, and keep it cultivated or mulched. In groups, plant about four feet apart.

Nothing adds more to the beauty of a place than to have the sides and background well filled with groups of shrubbery.

SPIREA VAN HOUTTEI
(Bridal Wreath)

Price	**Each**	1
2 to 3 feet	$0.35	$3

PURPLE LILAC

Price	**Each**	1
2 to 3 feet	$0.35	$2

PURPLE PERSIAN LILAC

Price	**Each**	10
1½ to 2 feet	$0.40	$3

JAPANESE BUSH HONEYSUCKLE

Price	**Each**	1
2 to 3 feet	$0.35	$3.0

MOCK ORANGE

Price	**Each**	1
2 to 3 feet	$0.35	$3.

TARTARIAN HONEYSUCKLE

Price	**Each**	10
2 to 3 feet	$0.35	$3.0

GREEN ELDER

Price	**Each**	10
3 to 4 feet	$0.35	$3.00

GOLDEN ELDER

Price	**Each**	10
3 to 4 feet	$0.35	$3.00

SNOWBERRY

Japanese Barberry

Famous for Low Hedges

Of all deciduous shrubs, this variety is, we believe, the most valuable for making low hedges. Of Japanese origin and of rather dwarfish habit of growth, low, regular and compact, requiring very little pruning. It has fine thorns and small round green leaves that change color in autumn to a brilliant fiery crimson.

Creates one of the most beautiful hedges imaginable and is made still more beautiful by great numbers of pretty drooping yellow flowers, which are followed in the fall by bright red berries, in great clusters, which adhere to the branches throughout the winter. It is used extensively for inside decoration, for it certainly is one of the most delightful berried shrubs in our entire collection.

This Barberry is absolutely hardy, of the easiest culture and will grow in any soil or situation. It will stand considerable shade, and can be grown under trees if not planted too closely to the trunks. It is of slow compact growth, but will eventually attain a height of five or six feet.

It is a variety notable because of absolute hardiness even in cold northern climates and it is for this reason that it has jumped so quickly into favor upon its introduction and its popularity has steadily increased each year, until now it is undoubtedly planted more extensively than any other deciduous hedge plant in the north. It grows with entire success in all parts of the country, north, east, south and west, and all who see it become enthusiastic at once about it. Also much used for bordering walks and ideal for group plantings in corners of lawn, while no better shrub can be found for screening foundation walls of house or porch. You will find Japanese Barberry thoroughly satisfactory.

Price, transplants	Each	10	100
1½ to 2 feet	$0.30	$2.25	$15.00

5 at 10 rate; 50 at 100 rate.

Barberry branch covered with bright red berries

Barberry makes beautiful hedges

Hill's Hardy Vines

Indispensable near the house. Plant Clematis, Climbing Roses and Honeysuckle about the porches, with perhaps a vine or two of the Chinese Wisteria to climb as high as the roof, and others if you have space. Stone or brick walls are always prettier when Ivy-clad.

CLEMATIS PANICULATA

Of very rapid growth, covering trellises and arbors with handsome, clean, glossy foliage, of a healthy green. Flowers are small, pure white, borne in immense sheets, almost completely hiding the foliage, and have a most delicate fragrance. Blooms in September.

Price	Each	3	10
2 yr. No. 1, Extra select	$0.35	$0.95	$3.00

JAPAN OR BOSTON IVY
(Ampelopsis Veitchii)

Grandest of hardy climbing vines for covering houses, churches, schools, etc. Its glossy leaves overlap each other, and its long, delicate young shoots stretch up the walls with free, rapid growth.

Price	Each	3	10
2 yr. No. 1, Extra select	$0.30	$0.80	$2.50

PURPLE CHINESE WISTERIA

Rapid growing vine with handsome foliage and flowers. The pea-shaped purplish flowers are profusely borne in immense drooping clusters seven to twelve inches long.

Price	Each	3	10
2 yr. No. 1	$0.35	$0.95	$3.00

HALL'S JAPAN HONEYSUCKLE

Nearly evergreen, its foliage remaining green nearly all winter. Beautiful yellowish white flowers, so deliciously fragrant as to be noticed for a long distance.

Price	Each	3	10
2 yr. No. 1, Extra select	$0.30	$0.80	$2.50

Clematis

HILL'S SPECIAL VINE COLLECTION

One each of the above superb climbing vines, extra-selected plants, four in all. Price......$1.20

HILL'S HERBACEOUS PEONIES

The Peony is today without a rival as a hardy garden favorite, and is quite naturally so, as no other hardy garden plant probably thrives as well with as little special care and produces so fine a display of gorgeous bloom.

FESTIVA MAXIMA

This is acknowledged to be the best white peony in existence, both in color and form. Of the purest white, splashed with a few streaks of crimson in the center.

Price	Each	3	10
Large, strong roots	$0.50	$1.40	$4.50

RUBRA SUPERBA

Large, late, vigorous, sometimes called Red Festiva Maxima. Its bright red double blossoms are gorgeous and make a delightful contrast to the pure white of the Festiva Maxima.

Price	Each	3	10
Large, strong roots	$0.45	$1.25	$4.00

PINK GRANDIFLORA

Immense heavy blossoms of deep rose-pink and very fragrant. One of the showiest and most beautiful pink varieties in existence. Also very pretty in bud. Blossoms profusely in mid-summer.

Price	Each	3	10

Hill's "Quality" Roses

19 Best Varieties

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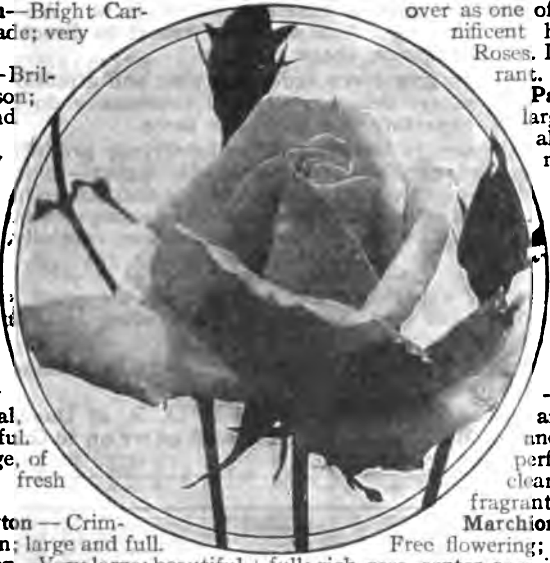

Anna de Diesbach—Bright Carmine; a beautiful shade; very large.

Alfred Colomb—Brilliant carmine-crimson; very large, full and globular.

American Beauty—One of the grandest and most beautiful Roses. Immense buds and flowers; rich glowing crimson. 40 cts. each. $3.25 for 10.

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Paul Neyron—The largest and finest of all. Flowers immense; shining pink, clear and beautiful; very double and full; finely scented.

Magna Charta—Large, double flowers; rosy red, flushed crimson.

John Hopper—Hardy; abundant bloomer; solid and regular flowers, perfectly double; clear, rosy pink, very fragrant.

Marchioness of Lorne—Free flowering; large, sweet and full; rich rose, center carmine.

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Ten roses, selected from the above fifteen varieties, our selection. Enough to fill a bed 6x10 feet. Plant 3 feet apart. Large sized bushes; to go by express. Price, $2.95.

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Baby Rambler—Rose hybridists certainly made a happy combination when they succeeded in creating this wonderful Rose. Imagine a bushy little Rose plant with all the beauty and great clusters of the Crimson Rambler, then add to this that it will bloom constantly all summer, and you have an ideal plant for borders and beds. Strong field grown plants.

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Crimson Rambler—The most popular Climbing Rose in cultivation. In all parts of the country during June and July the gorgeous crimson of this rose can be seen in all its glory. Attains a height of 10 to 20 feet in a single season.

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We never sell—or grow—sickly, unfit evergreen trees. We never wilfully make a misstatement of facts. We never misrepresent anything. And we never resort to direct untruthfulness in any manner, shape or form.

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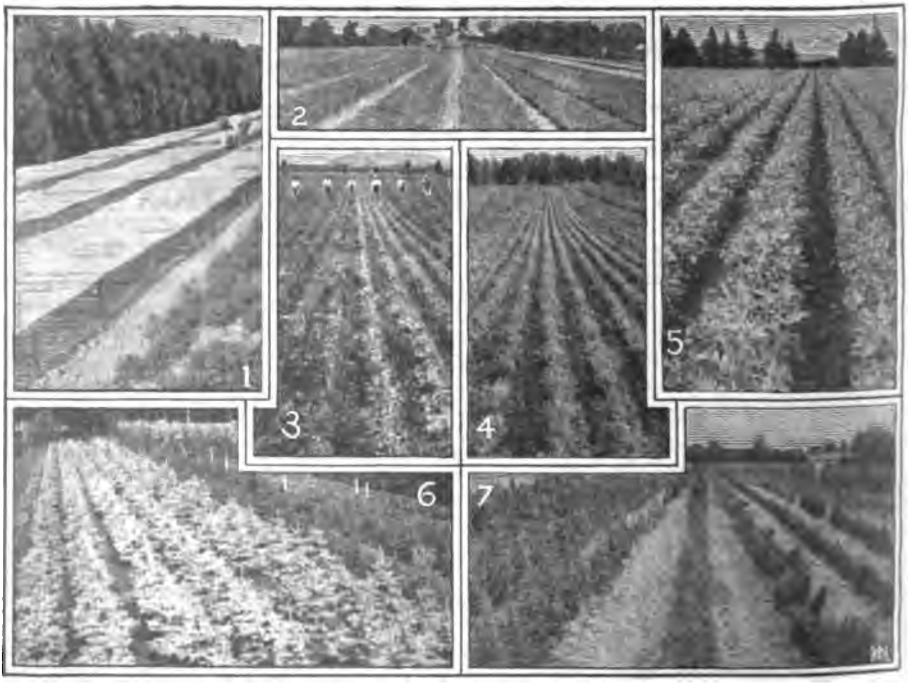

No. 1—One and two year old Evergreen Seedlings. No. 2—Two Million Pine Seedlings. No. 3—Cultivating a block of Norway Spruce. No. 4—Douglas Fir Transplant. No. 5—

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UNIVERSITY OF VERMONT
AND STATE AGRICULTURAL COLLEGE

VERMONT AGRICULTURAL

EXPERIMENT STATION

BURLINGTON, VT.

BULLETIN No. 188

APRIL, 1915

PROPERTY OF DIVISION OF
FORESTRY
COLLEGE OF AGRICULTURE
UNIVERSITY OF CALIFORNIA

Forest Planting in Vermont as an Investment

BURLINGTON:
FREE PRESS PRINTING COMPANY,
1915

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*In cooperation with Bu. An. Ind., U. S. Dept. Agr.

Plantation of White Pine on the Chas. Downer State Forest, Sharon, Vt.

Fifteen-year-old plantation of White Pine made by Prof. L. R. Jones in South Burlington, Vt.

Plantation of Scotch Pine, five years old, Sharon, Vt.

Plantation of Scotch and White Pine on bare sand, Lyndon State Forest. two years after planting.

BULLETIN 188 FOREST PLANTING IN VERMONT AS AN INVESTMENT

By A. F. Hawes, State Forester

Vermont Forestry Publication No. 17

Suggestions for the Prospective Forest Planter

1. A forest needs no fertilizer and very little care.
2. Taxation on forest plantations in Vermont is limited by law.
3. Only a rich man can afford to own unproductive land.
4. One acre of planted pine will produce a car load of lumber in 35 years.
5. A manufacturer can grow pine lumber for much less than he can buy it by the time it is grown.
6. A good growing forest often helps to sell the farm.
7. You can take a look at your forest plantation every Sunday, but you wouldn't know much about Wall Street if you camped there all summer.
8. If in doubt about planting, ask someone in your neighborhood who has tried it. The State Forest Service will send a complete list of Vermonters who have planted its trees.
9. The proceeds from one acre of pine plantation 45 years old would support a one-room school a year. If a town planted 45 acres, taxes for one school could eventually be eliminated.
10. In 1914 the State of Vermont spent about $370,000 for highway improvement. If the state owned ready to cut 1,250 acres of 40-year old pine plantation, the income would be sufficient to meet this expenditure. With 50,000 acres planted to forests 1 to 40 years old, taxation for state highway purposes at the present rate could be eliminated.

PROPERTY OF DIVISION OF
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LAND WHICH SHOULD BE REFORESTED IN VERMONT

The United States Census shows that the total area of forest and waste land in Vermont is 3,719,000 acres, or 64 percent of her total area. It is impossible to say how much of this is covered with growing timber and how much is non-productive.

Abandoned pasture. Much land formerly used for farm purposes has been allowed to revert to a wild condition during the past generation. While some of this land can be reclaimed for agriculture, the expense is so great that only the best land is worth reclaiming. Much is seeding up naturally with tree growth, but this process is slow and often non-economic because many poor species gain entrance, and because even the good species are too widely spaced to make good timber. It is not so much a question whether the owners of this class of land can afford to reforest it, as whether they can afford to pay taxes on unproductive land for a long term of years. Many Vermonters would be better off if they gave away the unproductive part of their lands. The new tax law, described on page 294, offers an incentive to reforest this class of land.

Cut-over woodland. Thousands of acres of land formerly covered with timber, but which have been cut-over during the past quarter of a century, are coming up with a more or less worthless growth of trees and brush. Where fire followed lumbering, such land is often not worth paying taxes on. Even where it escaped fire it has been shown[1] that the growth of hardwoods which usually follows is a much less profitable investment to hold than the same land would be planted to pine. In other words, the profits from planting are enough greater than those from natural hardwood growth to make planting of this cut-over land a good investment, provided it can be protected from fire.

Openings in the forest. In most of our woodlots and forests there are non-productive openings which seriously deplete the profit from the timber. These should be reforested artificially if they are not seeding in with the valuable species.

Total area to be planted. Altogether it is safe to say that at least 20,000 acres should be annually reforested in Vermont for the next 40 years. This would call for an annual planting of about 24 million trees, as compared with less than a million now planted annually.

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[1] Vt. Sta. Bul. 176. (1914), Vt. For. Serv. Pub. 18.

Planting during the last few years. The state forest nursery was established by an act of the Legislature of 1906, and forest planting started on a small scale in 1908; but no extensive planting was done until the establishment of the State Forest Service in 1909. During the past 6 years the planting in Vermont has been as follows:

1909 and 1910	572,200 trees
1911 and 1912	1,010,700 trees
1913 and 1914	1,497,650 trees
	3,080,550 trees

While the chief value of these plantings is educational in directing land owners' attention toward other lines of forestry and bringing about more extensive planting, it represents a total area of about 3,000 acres planted. This in itself seems small compared to the total area in the State which should be planted. If plantations were no more productive than natural forests, the actual results in lumber would be insignificant. But as every one realizes that a cultivated potato patch will produce more than one left to itself, so it must be remembered that a forest plantation is much more productive than a forest which has seeded up of itself. A pine plantation 40 years old will produce an average of 25,000 feet per acre, and one 50 years old will produce 37,000 feet per acre. The area already planted, therefore, may be expected to yield by 1954 about 75,000,000 feet, or by 1964 about 111,000,000 feet. At $10 per thousand feet, this means a stumpage value of $750,000 and $1,110,000 respectively. Allowing 17,000 feet of lumber as the average load of a freight car, the lumber produced from these plantations would fill a freight train of 4,400 cars. If it were all shipped to New York and Boston it would bring to the railroads in freight rates about $200,000; whereas, if it were all used in Vermont it would have an employment value from the stump to the finished product of from $2,500,000 to $6,000,000 according to its uses.

Success of plantations. Most of the forest plantations set out in Vermont during the past few years have been successful and have given satisfaction to their owners. In the great majority of cases fully 80 percent of the trees planted have lived through the first year; in many cases over 95 percent. In practically all cases where less than 70 percent have taken root "there's a reason." In a few of these the trees have not been delivered promptly, either through fault of the express companies or neglect of the purchaser to send for them. In several cases the trees have been carelessly planted. One man distributed trees every six feet on the ground and several hours later sent a crew to plant them, an exposure which of course, was fatal. In a few cases plantations have been damaged by fire or grazing. After all, the best indication that the plantations have given satisfaction is the fact that many land owners have continued planting from year to year.

LIST OF OWNERS WHO HAVE PLANTED DURING 6 DIFFERENT YEARS

Name and address	Trees	Name and address	Trees
Charles Richardson, Brattleboro,	16,000	T. D. Hobart, Berlin,	48,000
Dr. Wm. S. Stevens, Enosburg,	213,000	J. J. Parker, Sharon,	6,100
P. J. Farrell, Swanton,	4,500	F. E. Spellman, Springfield,	16,500

LIST OF OWNERS WHO HAVE PLANTED 4 DIFFERENT YEARS

Name and address	Trees	Name and address	Trees
E. B. Barrows, Brattleboro,	9,000	Hon. O. L. Martin, Plainfield,	10,500
A. L. Powers, Woodstock,	40,500	Scott Farm, Dummerston,	57,000
B. H. Lamb, Sharon,	4,300	C. C. Putnam & Son, Middlesex,	32,500
Burt Bros., Stowe,	20,000		

LIST OF OWNERS WHO HAVE PLANTED 3 DIFFERENT YEARS

Name and address	Trees	Name and address	Trees
Hon. E. S. Brigham, St. Albans,	2,000	A. A. Priest, Randolph,	10,000
C. A. Ricker, Groton,	10,600	Holden & Martin, Brattleboro,	35,000
L. C. Croft, Clarendon,	5,000	Bridgewater Woolen Co., Woodstock,	71,000
E. S. Stearns, Lincoln,	12,000	A. B. Morgan, Woodstock,	10,000
Hon. T. N. Vail, Lyndon,	26,000	Dr. W. L. Wasson, Waterbury,	10,000
Newton and Thompson, Brandon,	41,700	J. O. Cannon, Rochester,	34,000
Miss Mary Woodbury, Weathersfield,	25,200	W. D. Woolson, Springfield,	63,300
Miss C. Vaughan, Thetford,	5,000	Mrs. E. J. Sherman, Windsor,	5,000
Hon. D. T. Hanley, Milton,	14,500	A. B. Finney, Sharon	3,500
E. L. Bass, Bethel,	2,200	City of Montpelier, Berlin,	75,000

Of the earlier state plantations, those made at Sharon in 1910 are the most satisfactory. Plantations of three-year white pine transplants made the same season in the same way on this and the Plainfield forest, show great variation in results. About 95 percent of the trees on the Charles Downer state forest at Sharon, and about 65 percent of the trees on the L. R. Jones state forest at Plainfield, were alive in 1914. The chief factor which caused the relatively unfavorable outcome at Plainfield was apparently the strong grass growth, causing excessive transpiration of moisture and damage by grubs. Greater care should have been used on this site in removing the sod at the time of planting.

Of the three species of pine planted in 1910 at Sharon, the white and Scotch pine have thus far grown considerably better than the Norway pine. On this light loam soil the white pine has grown even better that the Scotch pine, a great many trees having increased over thirty inches during the past year. This experience is unlike that secured in the state plantations at Lyndon, and on forest lands owned by the University of Vermont in Burlington and South Burlington. In these locations, which are on sandy soils, the Scotch pine has considerably outgrown the white pine planted beside it.

Plantations of Norway spruce made on upland pastures at Sharon and elsewhere in grass, have not been very successful; while those made by Dr. Wm. S. Stevens, and Mr. T. D. Hobart and others, on moist land where there were more ferns than grass, have met with very good success.

SAFETY OF AN INVESTMENT IN FOREST PLANTING

Two things must be considered in regard to any investment: probable profit and safety.

It is often suggested that substitutes will be introduced for lumber, and it is probably true that the maximum prices which lumber will command, in the future, will be regulated by competition with other materials. It can be said, however, that with all the recent substitutes introduced the utilization of lumber and wood has increased in United States even more rapidly than the population. While it is likely that substitutes will take the place of lumber for certain purposes, it is very doubtful whether a sufficient variety will ever be invented to reduce materially the many demands made upon a lumber like white pine, which is used for so many purposes.

It is also claimed by some that so many men plant pine that there is likely to be an overproduction of this kind of lumber, as compared with hardwoods. The numerous uses of softwood, especially pine, will probably always make the demand for this wood exceed that for hardwoods, as it does at present. There will be, for a great many years, more land mismanaged, which will naturally reproduce with hardwoods, than well managed: and the amount of pine raised in all the plantations made will be insignificant for a great many years, as compared with the demand, as is readily seen from the fact that the country uses annually 3,138,227,000 board feet of white pine, and in all 30,526,416,000 feet of softwood lumber, or 78 percent of the total production.

The chief danger to an investment in forest planting is, of course, through forest fire. In this regard Vermont offers the best opportunities for safe investment of any of the eastern states, since her fire risk is less. During the six years, 1909 to 1914, inclusive, the total area burned in Vermont was 16,346 acres, an average of 2,725 acres a year. This area annually burned over is 0.09 percent of the wooded area of the state, as compared with 0.2 percent in New York, 0.24 percent in Maine, 1.5 percent in Massachusetts and Rhode Island, and 2.3 percent in New Jersey. In other words at this rate it would require 1,111 years to burn over the wooded area of Vermont, as compared with 500 years in New York, 417 years in Maine, 66 years in Massachusetts and Rhode Island, and 44 years in New Jersey.

Forest fire risk in Vermont, with the present organization, is not sufficiently great to deter anyone from planting except in particularly dangerous situations. The only reason that it is considered a serious obstacle is that the bad fire years of 1903 and 1908, before the Forest Service was organized, are fresh in the minds of most people, and because they read of the serious fires in other states. It should be said in this connection, however, that the conditions favoring fires in some sections of Vermont are steadily growing worse because of the extensive slash made by large lumber operations, and it is only by maintaining an efficient fire service that the present low risk can be maintained.

There is no other serious risk in connection with forest planting. Much damage may be done by live stock in the first years of a plantation, but this is easily eliminated by fencing. In some localities damage may be done by deer. There have been a few instances of deer browsing on planted pine, especially the Scotch pine. As deer will not be allowed to multiply greatly this is hardly a serious risk.

Insects and fungi are likely to do some damage, but probably no greater, if as great, than in the case of agricultural crops. They should not deter anyone from planting, except in the case of some species which are particularly susceptible to such damage.

KIND OF TREES TO PLANT

In deciding upon species to be used in forest planting, the forester considers three points:

(a) Like the lumberman, he considers first the price which the different species may be expected to bring. Woods bring the highest prices which have some special quality which recommends them for special uses. The woods in Vermont which today bring the highest prices, are: white pine, because of its straight even grain, softness, and the ease with which it is worked; white ash, because of its bending qualities; basswood, because of its evenness of texture, freedom from defects, &c.; and oak, because of its strength and ornamental graining. Such woods as hemlock, fir and beech would not be recommended on this basis.

(b) The forester also considers a point not taken into account by the lumberman, viz.: the rate of growth. If one is engaged only in manufacturing lumber he naturally does not care how long it took the trees to grow; but if one is engaged in growing timber he is as much interested in the rate of growth as in the price at which the lumber will sell. In Vermont the native trees of most rapid growth are white and Norway pine, balsam fir and poplar. Trees whose slow growth discourage planting are the native spruce, hemlock, beech, birch and maple. A few foreign trees are recommended because of their rapid growth, such as the Norway spruce, European larch and Scotch pine.

(c) He considers in the third place the enemies which damage the different trees. White pine, for example, is recommended for the first two reasons, but is seriously damaged by the weevil,[1] pine blight and the blister rust disease. While Scotch and Norway pine are not specially valuable, they are much more apt to be free from disease. One of the chief objections to the planting of oak is the fact that its foliage is a favorite food of the gipsy moth, which is almost sure to gain entrance into Vermont within a few years. The black locust would otherwise be well worth planting were it not for the locust borer.

Taking these various factors into consideration, the following trees are especially recommended for planting in Vermont: white pine, red or Norway pine, Scotch pine, European larch, Norway spruce, white spruce, balsam fir, white ash.

THE WHITE PINE—*Pinus strobus*

The white pine has been the chief tree advocated for planting in New England, because it thrives on dry sandy soils, as well as on the better classes of soils, because it grows very rapidly, and because it makes a soft workable wood which is in great demand. This ability of the white pine to grow on practically all soils recommends it highly for general use, but it prospers best where the soil is fairly deep, moist and loamy. The heavy clay lands of Addison county originally bore extensive pine forests, as the old stump fences still demonstrate.

Its root system is not large and there is no well developed taproot. The large topped trees grown in the open have a more extensive root system than the small topped trees of a close stand.

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[1] See p. 281; also Vt. Sta. Bul. 156, (1911), Vt. For. Serv. Pub. 4.

The action of light on the chlorophyll of the leaves is necessary to enable the leaves or needles of a tree to absorb carbon dioxid from the air. The carbon thus obtained, combined with water taken in through the roots, is the chief element of wood. The growth of a tree depends, therefore, not only upon the fertility and moisture of the soil, but upon the amount of light available for the leaves. White pine requires more light than the spruce, hemlock and maple, but less than poplar, white birch, tamarack and red pine. The trees requiring least light also cast the heaviest shade. Pine seedlings will live for years under the moderate shade of poplar and birch, but will soon die under spruce and hemlock. The light shade during the first few years may be a benefit in case of very hot, dry weather, but should be removed in a cleaning after the pines have become well established.[1]

On the whole the white pine is the most rapid growing tree of New England. Although individual specimens of other species may grow as fast, acre for acre pine will produce more lumber than any other species. A height growth of three feet a year is sometimes found on young trees, and a diameter growth on older trees of one inch; however, these figures are above the average.[2]

The great demand for white pine is due to the softness of the wood which makes it easily worked. For some purposes, as in the manufacture of matches, small boxes, &c., where short pieces can be used, the white pine is unequalled because of the fact that its branches grow in whorls and knots can therefore be discarded with very little loss. The greater the growth of the tree the longer is the clear piece of lumber available. For this reason white pine, grown on rich loam soils, will probably bring a particularly good price as the market becomes more specialized. In close stands the limbs die out younger and the knots are consequently smaller. The wood formed outside of these knots is perfectly clear. For these reasons a mixture of some deciduous tree, which casts a shade and breaks off the dead branches, may bring about a better grade of lumber; but the increased price thus secured for lumber would probably not make up for the deficiency in yield over that produced by a pure pine forest.

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[1] Vt. Sta. Bul. 156, (1911), Vt. For. Serv. Pub. 4.
[2] For tables of growth see Appendix.

White pine may safely be planted on any soil in Vermont up tc an elevation of 1,500 feet or northerly exposures, and 1,800 feet on southern and western exposures. On the better classes of soils, as those having considerable depth and mixture of loam, a spacing of 6 feet each way, giving 1,200 trees per acre, is sufficient. On the very dry, thin and sandy soils, a spacing of 5 by 6 feet is recommended, requiring 1,500 trees per acre.

Three-year transplants will usually be found most satisfactory, especially where there is any grass or brush growth. On worn-out pastures free from sod, two-year seedlings may be used with fair success. Three-year seedlings have no advantage over those a year younger.

RED OR NORWAY PINE[1]—*Pinus resinosa*

This tree derives its name from the fact that it was first noticed near Norway, Maine. It is native, although not common, throughout northern New England, and is found scattered over Vermont, as on the shores of Lakes Memphremagog and Champlain, Island Pond, Barnet Pond, on the Ottaqueechee near Woodstock, and elsewhere. In mixture with white pine its growth, for the first thirty years, is the more rapid of the two.

The main advantages of the red over the white pine lie in the fact that it makes a better growth, especially on poor soils, prunes itself of branches earlier, is more hardy, and is less subject to injury by insects and fungi. It withstands a range of temperature of from — 50° F. to +105° F., and thrives in sections where there are frosts every month of the year. It is usually found on soils where there is considerable sand and gravel, and for such soils, entirely lacking in clay or loam, is undoubtedly preferable to white pine for planting.

The Norway pine has a well developed tap-root when young, and develops strong laterals, so that it is usually very wind-firm. For this reason it may be planted not only where the soil is thin but on exposed sites. It is somewhat more exacting as regards direct sunlight than the white pine. Seedlings require direct sunlight and should not be planted in small openings of a forest or under any trees. It has been found, however, that Norway pine seedlings will stand sun exposure and weeds much better than will those of white pine.

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[1] Hawley & Hawes, Forestry in New England (Wiley); Woolsey & Chapman, Norway Pine in the Lake States. U. S. Dept. Agr., Bul 139. (1914).

Norway pine produces seed only once in 3 to 5 years. The cones are small and usually not plentiful, so that the seed is comparatively expensive. The young seedlings are particularly susceptible to damage by damping-off, and for these reasons nursery stock is usually more expensive than that of white or Scotch pine. Trees begin to produce seed at the age of about 25 years. Where the soil has been cleared of leaf litter good reproduction of this species is often secured 300 yards distant from seed trees, but the seed seldom germinates on a leaf litter.

After the seedling stage the Norway pine is remarkably free from enemies. On account of its thicker bark, it resists fire better than white pine, although young trees are, of course, killed by a hot fire. It is seldom attacked by the pine weevil and misshapen trees are very rare. It it also safe from the white pine blister-rust disease, and for this reason is recommended for planting in proximity to white pine suspected of being thus diseased.

While the wood of the Norway is somewhat redder in color, heavier and more resinous, it is sufficiently light, soft and straight grained to secure practically the same prices as white pine lumber. The wood is somewhat the stronger of the two. It is chiefly used for dimension stuff and house construction, also for boxes and shingles. Norway pine stumpage of old growth has sold as high as $12 per thousand feet on a national forest in Michigan. In Vermont it is seldom separated from white pine. Second growth stumpage has sold for $8.50 per thousand feet by the Champlain rule.

Norway pine should be planted pure, unless some slow growing tree which withstands shade is planted in mixture for the purpose of enriching the soil. The hemlock or native spruce could well be used in this way. When planted pure the trees should be spaced not nearer than six feet each way, since good pruning should be secured in this way. Three-year transplants are preferable, although two-year seedlings may be used where grass and weed growth is lacking.

SCOTCH PINE—*Pinus sylvestris*

This tree, which has been extensively planted in the eastern United States, is native throughout Europe, where several varieties are distinguished. It is common in Sweden and Russia and reaches an elevation of 2,700 feet[1] in the Vosges Mountains of eastern France.

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[1] Cannon, D., "Semer et Planter," Paris (1894).

and of 6,000 feet in the Maritime Alps and the Pyrennes.

Although it will grow on the driest and most acid soils, as well as on those rich in lime, it thrives best, like all other trees, on more favorable sites. There are probably few soils in Vermont too poor for this species up to an elevation of 2,000 feet. The Scotch pine has a strong root system, forms a dense crown cover, and is able to compete with practically all kinds of brush growth which it soon outgrows and smothers.

It has been established in Europe that the three trees which do the most to enrich the soil are beech, hornbeam and Scotch pine; hence this is a splendid species for reforesting worn-out and badly managed soils.

Its strong root system which enables it to monopolize the soil makes it disadvantageous to plant it in mixture with other species. Experimental mixtures with white pine have been made at the state forest in Sharon, but usually it should be planted pure.

The growth of the Scotch pine is very rapid after it becomes established, surpassing the white pine on very sandy sites. On the better loam sites the white pine grows about as well. The leaders of the Scotch pine sometimes make a growth of 40 inches, and often between 2 and 3 feet.

The quality of the wood is said to be best in the north of Europe, while in New England it can be compared fairly well with the native red or Norway pine. The wood as a fuel is in great demand by European bakers; it is also used for paper pulp, mine props, telegraph poles, railroad ties and for general building purposes. In France the lumber is considered superior to that of the American white pine.

Either two-year seedlings or three-year transplants may be safely planted on most lands. The latter should be used in competition with brush growth, but on open lands the former may be safely planted, being considerably stronger than two-year white pine seedlings.

The same spacing may be recommended as for white pine, but as the Scotch pines will usually be planted on the poorest sites, a spacing of 5 by 6 feet will be usually adopted.

EUROPEAN LARCH—*Larix Europoea*

While similar to our tamarack, this tree has some advantages over, and some characteristics somewhat different from, its American relative. Unlike the tamarack it prefers a well drained, although not a dry, soil. In the Alps of France and Italy it reaches an elevation of 3,000 to 6,000 feet,[1] and may, therefore, be classed as essentially a mountain tree. So long as the soil is sufficiently deep and drained the larch will thrive, even if the soil is acid. In Europe it reaches a height of 100 feet and seems to live longer in mixture with spruce or fir. A mixture with deciduous trees is also good for soil protection.

The larch is fully as intolerant of shade as the tamarack and should only be planted in mixture with trees which it can outstrip. In a mixed stand in Connecticut where larch and pine are of the same age, the larch are taller, but the pine are somewhat larger in diameter.

The wood is so resinous that it is very durable in air and water. In Europe it is much used in boat making and for ties and poles. The best grades of wood are grown on northern slopes.

Two-year transplants are recommended for planting. They must be planted very early in the spring before the leaves begin to come out.

NORWAY SPRUCE—*Picea excelsa*

The Norway spruce, like the Scotch pine, is native throughout northern Europe, but is not peculiar to Norway any more than the pine is to Scotland. It is distinctly a mountain tree, occurring in the French Alps as high as 6,000 feet. However it thrives not only on thin mountain soils but also on the plains, provided the soil is not too dry. It grows more rapidly than our own red spruce and the lumber is apparently as good. It is much in demand in Europe, not only for general construction purposes but for such special uses as the manufacture of musical instruments. Wood fit for this work is only found in the mountains. Trees 130 feet high are not uncommon in France. One of the best plantations of this species in this country is that of the Billings' Estate at Woodstock, Vermont, now 36 years old. Tests of the wood of these trees, made by the International Paper Company, showed that it made a whiter and stronger pulp than our native spruce.

This species is well adapted for planting in Vermont on any sites which are not too dry, up to an elevation of 2,500 feet. It can be especially recommended for planting openings in the forest, because a certain amount of shade does not interfere with its growth. On worn-out farm lands it is easily killed out by strong grass growth in dry seasons.

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[1] Cannon, D., "Semer et Planter," Paris (1894).

There are two objections to the Norway spruce. One is that in New England it does not seem to live much more than 50 years. This is not a serious objection from the standpoint of raising pulp, since an excellent crop may be secured in 30 to 40 years. The other objection is that it does not reproduce itself well. Although it seeds plentifully, seedlings in the neighborhood of old trees are rare. The tree has the same reputation in Germany where it is largely propagated by planting.

The young plants are very susceptible to the scorching influence of sunlight and for that reason planting on southern exposures should be done in the early fall, so that the trees may become established before encountering hot weather. On wet or cold sites, on the other hand, spring planting should be adopted. A spacing of 5 by 6 feet may be recommended, requiring 1,500 trees per acre. Only three or four-year transplants should be used.

WHITE SPRUCE—*Picea Canadensis*

This tree, which is native in northern Vermont, is one of the common and valuable timber trees of Canada. It has never attained importance with us, although it has been considerably planted for ornamental purposes. Its rapidity of growth and the fact that it is native recommend it for planting on sites similar to those recommended for Norway spruce. It is believed that its lumber is nearly if not quite as good, and that its reproductive capacity is much better.

Three-year transplants should be used, and planted 5 by 6 feet.

BALSAM FIR—*Abies balsamea*

The balsam fir is undoubtedly a tree which will be more appreciated in the future than it has been in the past and which may be recommended for planting under certain conditions in Vermont.

It is one of the most northerly trees of the continent, being confined to regions where the average summer temperature does not exceed 70° F.[1] It reaches its best development in Maine where there is an average rainfall of 43 inches. In Vermont it is found chiefly in the northeastern counties, but it follows the upper slopes of the Green Mountains south the whole length of the State. Conditions of moisture and temperature are often similar in swamps and on the upper mountain slopes, and the ground in both cases is apt to be covered with sphagnum moss. On the mountains, however, the fir, like other trees, does not attain as large size as at lower elevations.

The balsam fir is short lived and consequently never reaches the proportions often attained by spruce. Trees 2 feet in diameter and 90 feet high are rare, although occasionally found on the lower slopes in Vermont. The foliage persists from 8 to 13 years, considerably longer than that of white pine. The root system is shallow, being similar to that of the spruce. The lateral roots extend out in all directions a distance of 5 feet or more.

Fir cones ripen in one year, while those of pine require two growing seasons. Ordinarily the tree begins to seed when 20 years old and the size of a good Christmas tree, but seed is more plentiful as the trees advance in age. The dominant trees, or those in the open, produce more seed than those crowded in a forest. Good seed years occur at intervals of 2, 3 or 4 years, according to the locality. The seed requires more moisture for germination than spruce, and where moisture conditions are suitable they germinate freely on rotten logs, mineral soil, moss, or even on hardwood leaf litter. In pure stands of balsam there are often from 200,000 to 300,000 seedlings to the acre.

The balsam requires less light than tamarack, white pine and arbor-vitae, but more light than either spruce or hemlock. Small dead firs under heavy shade are much more common than dead spruce. It will live under shade the first few years, but requires more light as it develops.

For good development the balsam requires a richer and moister soil than spruce. It reaches its largest size on flats where the soil is a moderately moist, deep loam. In wet swamps with acid soils and on pure sand it grows very slowly.

The balsam is particularly apt to be attacked by fungi which cause its decay and death at an early age. Because of rot this tree is much more apt to be broken off by wind than to be uprooted, as is the spruce. It is also especially susceptible to injury by fire, since the cambium is but slightly protected by the thin bark.

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[1] Zon,—Balsam Fir. U. S. Dept. Agr., Bul. 55 (1914).

The balsam is a fairly rapid growing tree, though not as much so as the white pine. During the first 5 years its height growth is much slower than that of pine or Norway spruce, but from that point onwards until 60 years old, it averages, under favorable conditions, nearly a foot a year. Crowded in a forest its growth is somewhat less. The most rapid diameter growth is between the ages of 20 and 70 years, during which time it requires an average of 9 years for one inch of growth on the radius.

Balsam fir is used both for pulp and lumber. Because of its pitch content it is inferior for pulp purposes to spruce. Most pulp mills in the northeast now use balsam up to 40 percent mixed with spruce. For lumber purposes it is customary to sell balsam with spruce and there is usually no difference in prices, except for first grade.

Altogether there is considerable reason for planting balsam fir on cool, moist sites in Vermont, especially at elevations where white pine would not prosper. Three-year seedlings or four-year transplants should be used, and should be planted 6 by 6 feet.

WHITE ASH—*Fraxinus Americana*

This tree is scattered throughout the hardwood forests of Vermont but seldom forms pure stands. It prefers a moist, deep loam soil and is almost never found on dry, sandy sites. When grown in proper situations and with sufficient light, the white ash grows fairly rapidly.

Its seed production is prolific and natural reproduction near old trees is usually good, especially on a mineral soil rich in humus; but in most cases the seedlings die out for lack of light within a few years.

Ash lumber is in great demand for uses requiring bending qualities, and the best grades bring very high prices, e. g. $22 per thousand for logs delivered. Stumpage brings from $10 to $12 per thousand.

It is a very easy tree to plant successfully and may be recommended especially where hardwoods have been cut clean. Two-year transplants should be used, and when planted pure should be spaced 5 by 5 feet, requiring 1,700 trees per acre. On cut-over lands where there is some brush growth, or where a tolerant species like spruce is planted in mixture, white ash may be planted 6 by 6 requiring 1,200 trees per acre.

METHODS OF PLANTING

As most of the failures in forest plantations have been due to careless planting, it will be worth the while of the prospective purchaser to pay special attention to this section. The mattock or grub hoe is the best planting tool. Three methods of planting may be described.

(*a*) *Common method for planting 2 or 3-year nursery stock on worn-out farm land, or cut-over woodland, known as the cleft method.* The sod is first scraped away from a space about 1 foot square, then the mattock blade is buried, the handle raised and twisted to the right, making a hole at the left side of the blade. The roots of the seedling are distributed carefully in the hole under the blade. The blade is then removed and the soil is pressed with the foot firmly about the roots, so that there will be no air spaces. Care should be taken not to expose the roots to wind and sunlight before planting, since 5 minutes exposure is often enough to kill them, and to see that the trees are not planted deeper than they were in the nursery, since trees are often killed by burying.

(*b*) *Hole method.* In using four-year transplants or three-year seedlings, where the roots are long and irregular, greater care is necessary. After the sod is removed the earth should be taken out making a hole 6 or 8 inches deep and a foot in diameter. The roots are distributed in this hole, the tree being held carefully in an upright position. The fine soil is then replaced about the roots and the coarser soil on top pressed down as indicated in the preceding paragraph. In neither case is the sod replaced.

(*c*) *Furrow method.* In some cases, where strong grass land is planted to forest trees, as is sometimes done by water companies, the best way to insure the trees against competition with the grass is to plant them in furrows 6 feet apart across the piece. The planting in the furrows is done in one of the ways described under (*a*) and (*b*). Wherever stones are removed from the hole it is advisable to replace these on top of the soil around the trees to prevent evaporation.

CONVENIENT PLANTING CREW

For planting in the method described under (*a*), a crew of 4 or multiples of 4 will be found to be most efficient. Three of these men, equipped with mattocks, plant the trees, each following a straight line across the field, approximately 6 feet apart, sighting at stakes at the other end. The fourth man or boy carries the trees (the roots being covered with wet moss) in a basket or pail strapped over his shoulder, and he passes them out to the other three. Such a crew can plant from 2,000 to 4,000 trees a day according to the kind of land.

For planting in the method described under (*b*), a crew of 5 or 7 men is most efficient. With a crew of 7, 3 with mattocks, follow parallel lines, as in the previous case, and dig the holes, one man carries the trees and distributes them to the other 3 who plant them. This method is of course, slower. Such a crew will seldom plant more than 4,000 trees a day.

TIME OF PLANTING

There are two seasons in which forest planting can be done. Early spring planting usually gives the best results. Planting in the spring should begin as soon as the frost is out of the ground, for the reason that there is usually a dry spell in May or June. If the trees can be well established before such a time, a much larger percentage will survive. In 1913 the planting season began April 1, but usually in Vermont, the best time is between April 15 and June 1. Trees cannot be planted safely after they have begun to grow until the fall.

With some species, like Norway spruce on southern exposures, fall planting may be recommended. The chief point in its favor is that farmers are not quite as busy in the fall as in the spring, the highway work is not so strenuous and hence more men are available. On tracts where there is much planting to be done, fall planting doubles the length of time available. In Vermont the fall season extends usually from about August 20 to September 20.

Unpacking stock. The seedlings should be planted as soon as possible after arrival. If they cannot be planted at once they should be heeled in, near the site that is to be planted. A ditch, preferably under shade, may be dug, and, after the bundles are untied, the roots should be covered with earth in this ditch, shading artificially if necessary.

Puddling. Just before planting a thick mud should be made, preferably with a slight admixture of clay. A few hundred trees are taken from the box or ditch and their roots are dipped in this mud. These are then placed in a basket or pail and their roots covered with wet moss or cloth.

SPACING

Dense planting is desirable so that the trees will begin to crowd each other at an early age and automatically prune each other. They will also make a better height growth than if the tops are wide spread. Although European foresters have in the past planted more closely, the general tendency is now toward a spacing of about 6 feet. Better grades of lumber can undoubtedly be secured by planting more closely, but with our poor markets for material removed in thinnings a quick production of coarse material bids fair to be more profitable.

Experience with all kinds of forest has demonstrated that nature provides more trees per acre on poor soils than on the better sites. In other words, the crowding is so intense on good soils that fewer trees survive than on the poorer sites. Some species, which are more tolerant of shade than others, need to be more crowded in order to prune themselves. For these reasons we recommend a spacing of 6 by 6 feet, making 1,200 trees per acre, for the pines and similar species, on soils of average depth and richness. On the poorest soils, or with tolerant species like the Norway spruce, a spacing of 5 by 6 feet, making about 1,500 trees per acre, is recommended.

Spacing	Trees per acre	Spacing	Trees per acre
4 by 4	2,722	6 by 6	1,210
5 by 5	1,742	7 by 7	888
5 by 6	1,452	8 by 8	680

ESTHETIC PLANTING

Most of the plantations made in Vermont have been for commercial purposes, and the methods thus far described have had only commercial operations in view. As Vermont lands come more and more in demand for summer homes, forest plantations made upon esthetic principles will undoubtedly be valuable, and in many cases will very likely bring a price in excess of their commercial values. There is no question but that a natural forest is more beautiful than one which has been planted in straight rows. For esthetic purposes, therefore, a plantation should resemble as nearly as possible a natural stand. The trees should be spaced unevenly with some clumps and occasional openings. It is rather difficult to plant as many as 1,200 trees to the acre in this way. One of the best methods of planting irregularly is to scatter broadcast over an area as many pieces of wood as one wishes to plant trees. When the trees are set where these blocks fall there will be very few straight lines and the resulting forest will have a natural appearance.

PRICES OF NURSERY STOCK PER THOUSAND, SPRING, 1915

The prices of nursery stock for the present season are:

White pine	2-year seedlings[1]	$2.50
White pine	3-year transplants[1]	5.00
Scotch pine	2-year seedlings	2.25
Norway or red pine	3-year transplants	5.75
Norway spruce	3-year transplants	5.00
White ash	2-year transplants	8.00

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[1] Seedlings are raised in the seed-beds for one or two years and are then transplanted. A year after this transplanting they are called three-year transplants.

These prices are for trees packed and delivered to the express company, but do not include the cost of transportation.

The state nursery has no intention of competing with private nurseries, and, therefore, does not sell large ornamental trees. Neither are orders accepted at the above prices for less than 500 trees of any one kind. However, in order to interest land owners who have not hitherto undertaken forest planting, a special offer of a sample package is made during the spring of 1915 on the following terms:

A sample package may contain 250 three-year white pine or Norway spruce transplants, choice to be made by the purchaser. No mixed lots will be allowed. These packages will be sent by parcel post, postage prepaid. The price per package will be $2. This price is at a somewhat higher rate than for larger quantities, but it eliminates the necessity of driving to the express office for a small number of trees.

COST OF PLANTING

During the past 5 years the cost of labor has considerably advanced in Vermont, so that while nursery stock is cheaper the total cost of planting is as much, if not more, than formerly. The labor item for planting 1,000 trees on the state forests in 1913 was: Plainfield, $6.00; Lyndon, $4.23; Mendon, $5.12; Townshend, $5.15; Camel's Hump, $5.58. These prices included labor at $1.75 per day, and a foreman at $2.00 or $2.25 a day.

Estimating the average express charges as 25 cents per thousand, and the cost of hauling from the express office to the land at 10 cents per thousand, the cost of planting is as follows:

TABLE I. COST OF PLANTING 1,200 TREES PER ACRE

	Large plantations on fairly easy land, where labor costs $4 per thousand		Small plantations on difficult land, where labor costs $6 per thousand	
	2-year trees @ $2.50	3-year trees @ $5.00	2-year trees @ $2.50	3-year trees @ $5.00
Price of trees	$3.00	$6.00	$3.00	$6.00
Transportation	.40	.40	.40	.40
Labor	4.80	4.80	7.20	7.20
Total cost per acre	$8.20	$11.20	$10.60	$13.60

COST OF PLANTING 1,500 TREES PER ACRE

	Large plantations on fairly easy land, where labor costs $4 per thousand		Small plantations on difficult land, where labor costs $6 per thousand	
	2-year trees @ $2.50	3-year trees @ $5.00	2-year trees @ $2.50	3-year trees @ $5.00
Price of trees	$3.75	$7.50	$3.75	$7.50
Transportation	.55	.55	.55	.55
Labor	6.00	6.00	9.00	9.00
Total cost per acre	$10.30	$14.05	$13.30	$17.05

From the above examples it will be seen that the cost of planting an acre (with labor at $1.75) may vary from $8 for planting 1,200 two-year seedlings on easy land to $17 for planting 1,500 three-year transplants on brushy, rocky land.

There are forestry companies which make a business of planting by contract. Their prices for planting 5 acres or over with 1,000 three-year transplants per acre range from $13 per acre upward.

CARE OF FOREST PLANTATION

The most important thing in forest management is to furnish adequate fire protection. There are many tracts near railroads, or large lumber operations, where the danger is so great that forest planting is hardly justified. Whenever planting is done it is well to take measures for protection. Large plantations of conifers should be broken up into blocks of ten acres or less, either by plowed fire lines about one rod wide, or by planted belts of deciduous trees four rods or more in width. Plowed lines may be kept free from vegetative growth by harrowing two or three times a year. Belts of deciduous trees may be made more effective by annually raking up and burning the leaves and broken branches.

Stock should be excluded from plantations for at least eight years after planting. Cows do not eat pine tops but they break them off by rubbing againt them when the trees are 2 to 5 feet high.

Sometime within the first 6 years of the life of a plantation it is usually desirable to make a "cleaning." This consists in removing any brush or inferior trees which are crowding the more valuable planted trees. Poplar and birch are especially apt to damage young pine by rubbing off the terminal buds. Blackberry and raspberry bushes often retard growth by shading the young trees. It is not necessary to remove the injurious growth from the plantation, but it is often sufficient to break it off near the base. This can be done at comparatively slight expense.

In all plantations of white pine a careful inspection should be made every summer for the weevil until the trees are above its reach.[1] This insect seldom kills the tree but invariably works in the main shoot causing it to wither and die, usually in July or early August. The next year one of the side branches straightens up and forms the leader, but there is always a slight crook in the tree. In badly infested regions the same tree is often attacked repeatedly and the numerous crooks give it a much deformed and stunted appearance. Of course its value for timber purposes is much diminished. The insect seems to prefer trees from 3 to 30 feet in height, though it occasionally attacks tall trees. Its ravages are worse in the southern range of the species than in Vermont. The adult is a reddish-brown beetle about half an inch long with a pronounced snout. The pupa is creamy white and of about the same length as its adult. The grub is also white and of varying length up to one-fourth of an inch, according to development. The infested top is badly decayed at the close of the season and is cut up with tunnels filled with borings. The first sign of the attack is disclosed by the wilting of the needles. The beetles deposit their eggs under the bark of the main shoots in May or June, and when the grubs hatch after a week or two they bore inward and in a downward direction to the pith. The grubs are much reduced by natural enemies, mostly parasitic insects. They transform into pupae and adults and during July and August of the same year, when the adults are fully matured, they bore their way out and seek suitable places in which to pass the winter.

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[1] Vt. Sta. Bul. 156 (1911), Vt. For. Serv. Pub. 4.

The only way of fighting this insect is to cut off the infested top during June and July before the beetles have escaped. The safest way of destroying the weevils is to burn these tops; but as they often contain also a large number of minute insects which prey on the weevil a modification of this procedure has been suggested by Hopkins. A perfectly tight can is prepared with but one opening. The infested tops are placed in this can and the opening covered with a very fine wire mesh, so fine that the beetle cannot escape, whereas the parasites, which are much smaller, get out and attack other weevils. Either form of treatment must be repeated several successive years, as it is impossible to catch all the weevils in a single season.

TAXATION ON FOREST PLANTATIONS

No. 40 of the Acts of 1912 makes it possible for the owners of forest plantations and of young natural forests to determine in advance with some accuracy what the taxes are likely to be. Without knowledge of this kind one has little incentive to plant forests. This enactment and illustrations of its application follow.

AN ACT RELATING TO THE TAXATION OF YOUNG TIMBER

It is hereby enacted by the General Assembly of the State of Vermont

Section 1. An owner of land who wishes to classify the same under the provisions of this act shall make application for such classification to the state forester accompanied by such description of the land as the state forester may require. Application having been made in due form, the state forester shall examine the land in question, and if he finds the requirements hereinafter provided have been fulfilled, he shall issue a triplicate certificate of classification, the original to be filed in the office of the state forester, one copy in the office of the town clerk of the town in which the land is located, and one copy given the owner.

Sec. 2. Cut-over or other land fully stocked with forest trees not more than fifteen years old, except scattered trees the presence of which does not increase the assessed value of the property; cut-over or other land incompletely or partially stocked with forest trees not more than fifteen years old, when planted with a sufficient number of additional trees to assure a spacing of approximately six by six feet over the entire area; and open land planted with forest trees not less than one thousand to the acre; provided in each case that the trees planted are of the following species: ash, basswood, oak, maple, white, Scotch or Norway pine, European larch, white or Norway spruce, or any other species approved by the state forester, and also provided that said state forester approves the manner in which the trees are planted, and provided further that said land is outside the limits of a city or village, shall be classified as forest land, and shall thereafter be taxed annually at the local rate on a valuation of the land alone, said valuation to be established by the local listers at the time of classification, but in no case to exceed three dollars an acre, said valuation to be maintained until the year 1950. In the year 1950 the land alone shall be revalued without regard to the above limit, and the valuation then established shall be maintained for a further period of fifty years, tax being levied annually on said valuation at the local rate. Whenever a commercial cutting is made a tax of ten percent shall be levied on the gross stumpage value of the amount cut.

Sec. 3. Classification as forest land for purposes of taxation shall be continued so long as proper forest conditions are maintained thereon. Use of said land for pasture; destruction by fire of the tree growth and failure of the owner to restore forest conditions; removal of tree growth and use of land for other purposes; or any other changed conditions which, in the opinion of the state forester, indicates that proper forest conditions are not being maintained, shall be considered sufficient grounds for cancellation of classification. When requested by the town listers, or whenever he may deem it necessary, the state forester shall examine classified forest land, and if he finds that the provisions of the law are not fully complied with, he shall forthwith cancel the classification of said land, sending notice of such cancellation to the town clerk of the town in which the land is located, and the owner thereof. Said land shall thereafter be taxed under the laws governing the general property tax unless it be granted reclassification as forest land at a subsequent date. Whenever a classification is cancelled, the owner of the land shall be required to pay a tax on the stumpage value of the standing timber amounting to one-half of one percent per annum for the entire number of years that said land has been under classification. This tax shall be in addition to any annual tax or yield tax which may have been paid, or may be collectible.

Sec. 4. All products of cuttings on classified land shall pay a yield tax as provided in sections 2 and 3 of this act except material cut for domestic use and which is not to be sold, or material removed in the form of thinnings to improve the condition of the remaining stand, and whose stumpage value does not exceed the cost of removal. Whenever a cutting, other than excepted above, is made the owner of the timber shall file with the local listers and the state forester, a sworn statement of the quantity which has been cut, and its stumpage value. If either the assessors or the state forester deem the value as stated too low the state forester shall determine the stumpage value and report the same to the listers and the owner. Should the owner be unwilling to accept the valuation as given by the state forester, he may refer the matter to a special board consisting of the first selectman and the town clerk of the town in which the land is located together with the state forester, whose decision with regard to the valuation shall be final.

Sec. 5. Sections 368, 369 and 370 and subdivision XIV of section 496 of the Public Statutes shall apply only to land planted to forest trees prior to January 1, 1913.

Approved February 13, 1913.

A few illustrations of the manner in which this enactment operates.

1. A has a tract of 100 acres which is fully stocked with spruce from 1 to 15 years of age, which is now pastured. He wishes to have it classified. What must A do to have it classified; and what will his taxes amount to for the next 20 years?

He must agree to exclude all stock and make application for classification to the State Forester, who will have the land examined. If accepted, the land will then be assessed at not over $3 an acre, and probably at this figure. If the tax rate is two percent, i. e. $2 on a dollar, the annual tax on the land will be $6. This tax in 20 years would amount to $178.67 at 4 percent compound interest. If no cuttings were made during this period there would be no other tax.

2. B owns a tract of 200 acres, half of which is fully stocked with hardwoods from 1 to 15 years old; the other half is open pasture land. What must he do to have this land classified? What

would the tax on this amount to in 25 years if he removed 100 cords for his own use?

He can fence off the half which is fully stocked and apply to have this classified; or he may reforest the remainder and apply for classification for the whole area. If the whole area is classified at $3 an acre the total valuation would be $600. If the tax rate is 1.5 percent or $1.50 on the dollar, the annual tax would be $9. This tax at 5 percent compound interest for 25 years would amount to $429.54. There would be no tax on the wood cut since it is used by the owner.

3. C owns 300 acres which is partially covered with young trees from 1 to 15 years old. He wishes to make an improvement thinning in 20 years and another cutting in 30 years. What must he do to have the land classified and what would his taxes amount to?

In order to have it classified he must interplant so that the spacing will be approximately 6 feet over the entire area. If the land is valued at $3 an acre, and the tax rate is 1 percent or $1 on the dollar, the valuation would be $900 and the annual tax $9. At 4 percent compound interest this would amount in 30 years to $504.76. If he removes 1,000 cords in the thinning, which is worth on the stump $1,000 and it costs to remove the wood $1,500 there would be no tax on this wood. If at the end of 30 years he sells 500,000 feet of lumber, worth on the stump $3,000, his tax on this cut will be $300.

RETURNS FROM PLANTATIONS

The only way of forecasting the probable returns from a forest plantation is by means of yield tables. Unfortunately such tables have been made for comparatively few species. The following table for white pine gives conservative results for plantations, because it is based on natural, unthinned stands in New Hampshire.

TABLE I. YIELD TABLE SHOWING YIELD IN BOARD FEET WHICH UNIMPROVED NATURAL SECOND-GROWTH WHITE PINE HAS PRODUCED IN NEW HAMPSHIRE[1]

	Board feet per acre		
	Best pine soil	Medium soil	Poorest soil
20 yrs.	4,600	3,150	1,700
30 "	15,100	10,800	6,550
40 "	33,550	25,000	16,450
50 "	47,450	37,800	27,650
60 "	57,300	47,400	37,500
70 "	65,900	55,800	45,700
80 "	73,300	62,850	52,400
90 "	80,050	69,000	57,950

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[1] N. H. For. Com. Rpt. 1905-06.

TABLE II. MONEY YIELD TABLE—WHITE PINE

	Stumpage at $8 per M.		Stumpage at $10 per M.		Stumpage at $12 per M.	
Soil	Quality I	Quality III	Quality I	Quality III	Quality I	Quality III
20 yrs.	$ 36.80	$ 13.60	$ 46.00	$ 17.00	$ 55.20	$ 20.40
30 "	120.80	52.00	151.00	65.50	181.20	78.00
40 "	268.00	132.00	335.50	164.50	402.00	198.00
50 "	379.20	220.80	474.50	276.50	568.80	331.20
60 "	458.40	300.00	573.00	375.00	687.60	450.00
70 "	527.20	365.60	659.00	457.00	790.80	548.40

The following yield table for white ash was made by a study of individual trees, and is not, therefore, as accurate as the pine table.

TABLE III. YIELD TABLE FOR PURE WHITE ASH BASED ON THE MEASUREMENTS OF RAPID GROWING INDIVIDUALS

	Number of trees per acre	Volume per tree	Total volume per acre	Value of stand[1]
30 yrs.	160	90	14,400	$ 86.40
40 "	145	135	19,575	117.60
50 "	135	185	24,975	150.00
60 "	128	235	30,080	240.64
70 "	121	275	33,275	266.16
80 "	114	320	36,480	291.84
90 "	105	365	38,325	306.56

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[1] Value is based on a stumpage price of $6 per thousand board feet for stands under 55 years, and of $8 for older stands.

PROFIT FROM FOREST PLANTING

Table II indicates the probable financial returns from pine plantations of different ages on the best and poorest soils. In order to form an idea of the profit which these figures represent it is necessary to compute the cost of the plantation at these various ages. Table IV gives this data in three sets of figures based on an initial cost of planting of $8, $12 and $16 per acre respectively. It is assumed in these calculations that the plantation would be classified under No. 40 of the Acts of 1912, that the land would be valued at $3 per acre, and that the tax rate on the land is 2 percent. The investment in the land, cost of planting and taxes on the land are computed as 4 percent and the yield tax is based on an assumed stumpage value of $10 per thousand.

TABLE IV. COST OF PRODUCTION PER ACRE

	Cost of planting per acre					
	$8		$12		$16	
Soil	Quality I	Quality III	Quality I	Quality III	Quality I	Quality III
20 yrs.	$ 27.47	$ 24.59	$ 36.23	$ 33.35	$ 44.99	$ 42.11
30 "	51.10	42.59	64.06	55.55	77.02	68.51
40 "	89.05	71.96	108.25	91.16	127.45	110.36
50 "	131.83	111.99	160.27	140.43	188.71	168.87
60 "	184.30	174.50	226.38	216.58	268.46	258.66

Table V shows the profit which may be derived from one acre of forest plantation, stumpage figured at $10 per thousand feet, as displayed in Table II, and the cost figured at three different rates for planting, as given in Table IV. It will be seen, for example, that a plantation costing $12 an acre to form will produce in 50 years a profit of $314 on the best soil and $136 on the poorest soils over and above all costs, including taxes and compound interest at 4 percent.

TABLE V. PROFIT PER ACRE ABOVE 4 PERCENT COMPOUND INTEREST, CALCULATED FOR A STUMPAGE PRICE OF $10 PER THOUSAND FEET

	Cost of planting per acre					
	$8		$12		$16	
Soil	Quality I	Quality III	Quality I	Quality III	Quality I	Quality III
20 yrs.	$ 18.53	$ 7.59 (Loss)	$ 9.77	$ 16.35 (Loss)	$ 1.01	$ 25.11 (Loss)
30 "	99.90	22.91	86.94	10.05	73.98	3.01 (Loss)
40 "	246.45	93.54	227.25	73.34	208.05	54.14
50 "	342.67	164.51	314.23	136.07	285.79	107.63
60 "	388.70	200.50	346.62	158.42	304.54	116.34

VALUE OF LAND THAT CAN BE PLANTED PROFITABLY

The question often comes up as to how valuable land can be planted to white pine. Naturally the more valuable the land the lower rate of interest will be borne on an investment in planting. The table given below is based on a cost of planting of $12 an acre. As shown above, this is a liberal figure, for the cost is quite as apt to be below as above this amount. It is also based on an assumed stumpage value of only $8 per thousand, which is undoubtedly the minimum value especially for future calculations. If a larger value were assumed the percentage of profit would be correspondingly larger. However, under these conditions the table shows that land valued at $10 an acre, planted at a cost of $12 should yield 4 percent compound interest on the investment on the poorest soils, and on the best soils as high as 6 percent. On lands valued at $3 an acre a 7 percent profit should be realized in 40 years.

It should be realized that it costs practically as much to plant an acre of the poorest soil as of the best, but that the returns are very much less. It must be borne in mind that these qualities of soil do not refer to agricultural conditions, the best forest soil often being on a par with the poorest agricultural soil, since the forester does not contemplate using land for forestry which could more profitably be utilized for agriculture. Bearing these things in mind, it will be realized that a person contemplating an investment in forest planting will do well to study soil conditions, just as for farming, and invest his money in planting land which will produce the highest returns. He will see that whereas he may easily have a 5 percent investment on land costing $10 an acre, if the soil is productive, it would be impossible for him to derive such a profit from the poorest land, if it cost him more than $5 an acre. Tax listers should take these matters into consideration and list forest lands by a gradation of values according to their productive powers, in the same manner as with agricultural lands.

TABLE VI. PERCENTAGES OF PROFIT OBTAINABLE FROM WHITE PINE PLANTATIONS ON LAND OF DIFFERENT VALUES, WHERE PLANTING COSTS $12 AN ACRE, AND WHERE LUMBER IS WORTH $8 PER THOUSAND FEET ON THE STUMP

Age in years	Quality I				Quality III			
	Value of land per acre							
	$1	$3	$5	$10	$1	$3	$5	$10
	Percent				Percent			
20	4.5	4	3.5	3	0	0	0	0
30	7	6.5	6	5.5	4	3.5	3.5	3
40	7	7	6.5	6	5.5	5	5	4
50	6.5	6	6	5.5	5.5	5	5	4
60	6	5	5	4.5	5	4.5	4.5	4

In this connection the question naturally arises as to what is agricultural land and what is forest land. It must be admitted that there is no distinct line of demarcation. Much land in Vermont which was formerly profitable for sheep raising is today more profitable for timber production. The change is not so much due to the deterioration of the soil as to competition with Australia and other sheep raising sections, and to the growing scarcity of lumber throughout the United States. During recent years the number of cattle as well as sheep in Vermont has been steadily falling off. This has resulted in a diminishing demand for pasture and, consequently, a lowering of the profit derived from its use. True forest soil is the land which can never be used for agriculture; yet who can say what conditions a dense population of two or three centuries hence may bring about? All that we can hope to do is to predict for a period of 40 or 50 years what land can be profitably used for agriculture, and to advocate the use of the rest for forest production. Much land in Vermont is so steep, or rocky, or for other reasons unfavorable for agriculture, that it is practically certain that it will not be profitable for agriculture during the present century. Much of this land classifies as third quality forest soil and private owners should be conservative about investing money in reforesting it. It is chiefly a type of land which should be owned and reforested either by the state or town, since the indirect benefits to the community would repay public expense though they would not compensate an individual owner.

There are in addition to these true forest soils, large areas of Vermont land, some of which have been used for agriculture in the past, and all of which may be profitably thus used at some future time. Any of this land which can be profitably cleared up and used for farming should be so used; but land that is far distant from a market, or upon which the cost of improvement would be excessive, or which for other reasons is not adapted to farming in the near future should be used for forest production. If after the growing of one forest crop conditions have so changed as again to make farming profitable on this land, it will be found that the forest has considerably enriched the soil. In some portions of Europe such an alteration of wood and farm crops has long been recognized as a legitimate form of agriculture.

It is not, however, a simple matter to determine at present just what land can be profitably used for agriculture. A progressive farmer, with due regard to labor income, might get a profit from a tract from which another man, considering only yield per acre, might derive no profit. In the same way, some pastures which are now liabilities rather than assets could be turned into assets by proper management. However, in dealing with average conditions of land we must also deal with average abilities to handle the same, and the average profits now being derived from them. The best way of determining the income from a pasture is to ascertain how much rental it would yield, since that depends somewhat upon the local supply and demand of pasture.

Table VII shows the accrued income on pasture land figured at 4 percent, compound interest for periods from 20 to 60 years. Comparing these figures with those in Table V, one may ascertain the relative profit from pasturing a certain area and from planting to forests. For example, a net income of 25c an acre on pasture, over and above interest on the value of the land and taxes, amounts to $7.45 in 20 years at 4 percent compound interest. Comparing with Table V one finds that allowing $12 an acre as the cost of planting the profit in 20 years on the best soil is $9.77 per acre, and that on the poorest soil the loss is $16.35 an acre. For such a short period the advantage in this case would be in favor of pasture.

A net income from pasture of $1.00 an acre a year amounts in

40 years to $95 while the net income from a plantation costing $12 to establish ranges from $73 to $227 an acre. Evidently for such a long term a forest plantation is more profitable than pasturing even at a net income of $1 which is rather a high rental for the class of land which will usually be planted to forests.

TABLE VII. ACCRUED INCOME FROM PASTURE RENTALS

Age in years	Net income per acre per year			
	$ .25	$ .50	$ 1.00	$ 1.50
20	7.45	14.90	29.80	44.70
30	14.00	28.00	56.00	84.00
40	23.78	47.50	95.00	142.50
50	38.20	76.40	152.80	229.20
60	59.40	118.90	237.80	356.70

COST OF RAISING PINE LUMBER

In the preceding pages the probable profit from forest planting has been discussed from the standpoint of the man who is to sell his lumber. There is even greater incentive for the manufacturer who uses a large amount of lumber to raise his own. By so doing he is sure of a sufficient local supply in the future to enable him to continue his business, and he can determine in advance fairly accurately what this supply will cost him. Without such a supply he must purchase from different sources, paying whatever is the market price at the time, and probably having to pay the freight rates for a considerable amount of it. He should realize that land owners in the future will be more intelligent about the selling of lumber than at present, and that bargains in woodlots will be increasingly scarse.

The local supply of lumber is likely to have an increasing influence on manufacturing business. It will be more and more difficult to compete with concerns having a local supply of lumber to meet their requirements.

The following calculation was made for a Vermont manufacturer who uses 800,000 board feet of pine annually, to determine how much it will cost to raise this amount annually. From Table I it is seen that it is fair to assume a production of 30,000 board feet per acre in 40 years. To cut 800,000 feet one must have 27 acres of 40-year old plantations. In order to cut 27 acres a year for 40 years a total of 1,080 acres is required, or, approximately, 1,100 acres.

Cost of 1,100 acres of land at $3	$ 3,300
Cost of planting 1,100 acres at $10	11,000
	$14,300
Value of land, $3,300 at 4 percent compound interest for 40 years	$12,540
Cost of planting, $11,000 at 4 percent compound interest for 40 years	52,800
Tax of 1 percent on land value under No. 40, Acts 1912, at 4 percent compound interest for 40 years	3,135
10 percent yield-tax on stumpage, valued at $15 per thousand	49,500
Total cost of growing 32,000,000 board feet	$117,975
Average cost per 1,000 feet	$ 3.68

If pine stumpage sells for $15 per thousand at the end of 40 years, the manufacturer in question and his successors would save $11.32 on a thousand feet, or $9,056 annually. In the case of less productive land the cost of raising lumber would be correspondingly greater, as would also be the case, of course, if the land or the planting cost more than in the above example. On the other hand it is possible to improve upon all of these figures, though one is not likely to obtain first quality land for less than $3 an acre. If stumpage is worth less than $15 per thousand at the time of cutting, the yield-tax would be correspondingly less. With stumpage figured at $12 the yield-tax would be $38,400 instead of $49,500, the cost of growing would be $3.34 per thousand instead of $3.68, and the profit would be $8.66 per thousand instead of $11.32.

In both of the cases above cited the profit in raising stumpage is predicated on the supposition that the manufacturer could purchase plenty of lumber in his own locality at the market price. As a matter of fact this will very seldom be the case, unless the manufacturer at least furnishes an example sufficient to interest others in this form of investment. In estimating his profit from planting we should, therefore, add freight charges to the stumpage price of most of the lumber purchased for a large business. If a concern, such as the one mentioned above, is obliged to buy half of its lumber from a distance, the freight charges on the same may well amount to $1,000 a year, which must be added to the annual profit if the manufacturer raises his own lumber near at home.

In the sale of wood-using industries in the future a supply of available growing timber suitable for the future needs of a business will be a very important asset, and a wood-using industry which has no such supply will find itself very much handicapped as compared with those in the vicinity of extensive forests.

It is said that the stockholders of one of the large Canadian paper companies, who are mostly English, always inquire first as to the area of the company's lands reforested, before they look into the items of receipts and expenditures. The time will come in this country when stockholders will demand that their business be run on a permanent basis, and that an annual inventory be submitted, showing the exact condition of all lands owned. Inventories of this sort would not be valuable assets to most companies at present.

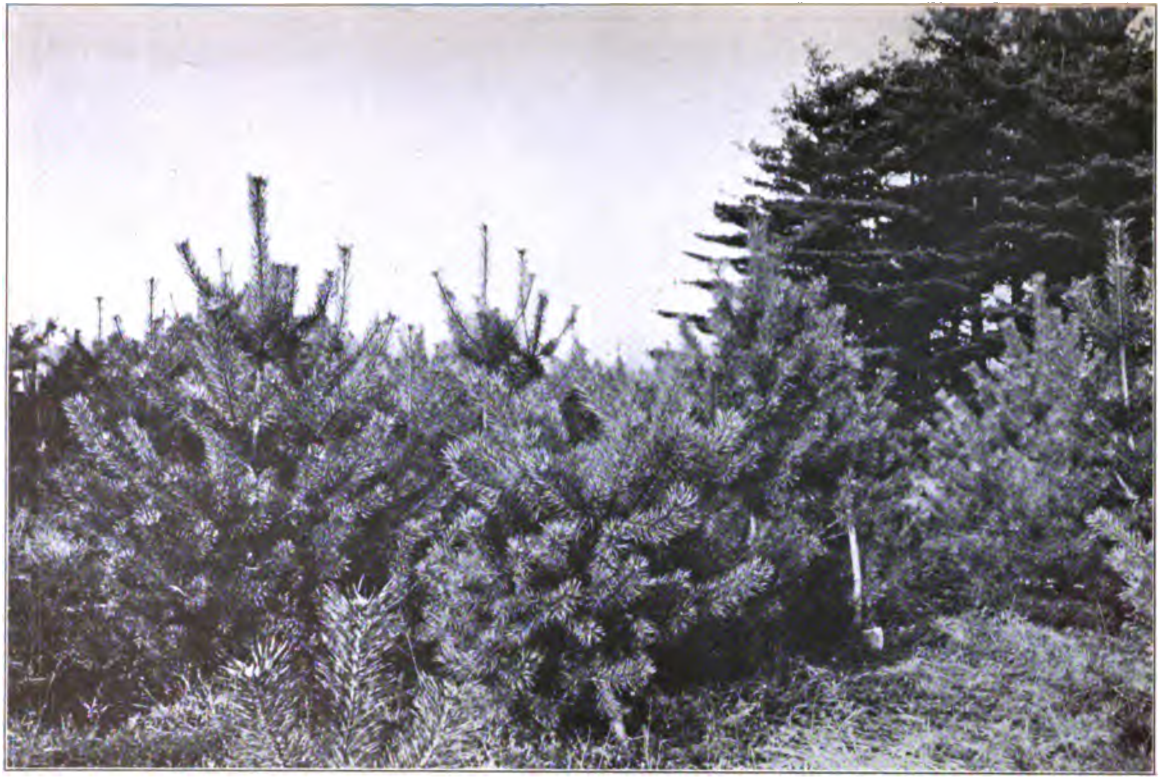
SCHOOL ENDOWMENT FORESTS

In several foreign countries municipalities derive a considerable portion of their revenue from municipal forests. A village or city, being a permanent institution, can forego immediate returns for greater future returns and is, therefore, well adapted to manage forest property. This management is also usually safeguarded from local political vagaries by placing it entirely under the direction of the central forestry department, although the money goes directly to the municipal treasury which has entire control of expenditures. As examples of such communal or municipal forests, the following may be mentioned, although they are by no means exceptional.

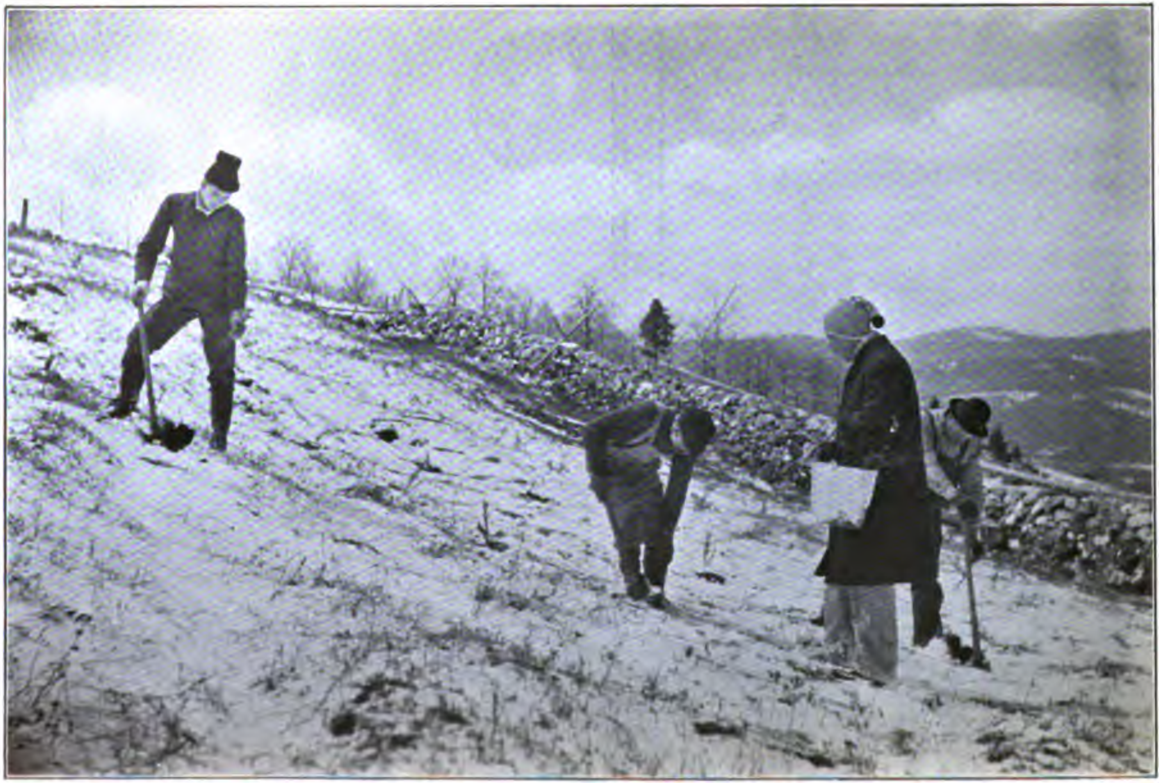
Forbach, Baden, with about the same population as the Vermont town of Bethel, enjoys an annual revenue of nearly $18,000 from its forest. Such a revenue would nearly eliminate taxation in Bethel.

It is often said that we cannot argue from conditions in foreign countries; but unless we admit that representative government is a failure there is nothing in this argument. Natural conditions here are equal to those in Europe. Our climate, soil and species of trees are as good or better than those in Europe. In fact, without much difficulty it can be shown that conditions for investing in forestry are better in New England at present than in Europe. While lumber is now worth about twice as much in Europe as with us, our prices are kept down by the immense supply of virgin timber in the west and by the fact that New England has no protective tariff, as has Germany. As soon as the virgin timber of the west is depleted, which will be before our present plantings are mature, our prices will be practically equal to those of Europe. In fact it is quite probable that the time is coming when lumber will be even more costly than in Europe. The city of Zurich, Switzerland, recently purchased about 1,700 acres to add to its forest, paying an average of $80 an acre for the land alone. Many other purchases at similar high figures might be mentioned. In New England, on the other hand, large areas can be secured for from $2 to $6 an acre. The State of Vermont recently purchased a tract of 3,000 acres, carrying a large amount of timber, for $3.25 an acre. When it is said that forest planting in Europe brings comparatively small interest on the investment it must be remembered that there is a great disparity between land values here and abroad, and that now is the time to make investments of this kind. From what has already been said as to the relative fire risk in Vermont and the rest of New England, it may be seen that the opportunity for safe and profitable investments in forest planting are as good in Vermont, if not better, than elsewhere.

Several attempts have been made recently to popularize the idea of municipal forests in this country, notably those of the Massachusetts Forestry Association. To the writer the great difficulty with this movement has been to bring the public to distinguish between parks handled for recreation, which they are accustomed to, and forests handled chiefly for profit, but also available for recreation. Few Vermont towns can afford the luxury of a large park, but many could well make a long time investment. The purpose of No. 24 of the Acts of 1915, is to provide for municipal forests which would be without question for investment purposes. This law, therefore, provides for the establishment of school endowment forests by any towns so voting. Any tract of forty acres or over, owned by a town, may, upon the approval of the state forester, be set aside as a school endowment forest. The town may secure the trees to plant this land from the state nursery. Table V, giving the probable profits from plantations shows that plantations costing $12 an acre to form should yield a profit in 50 years of from $136 to $314 an acre. Hence a town which planted 40 acres of the poorest forest soil might have a net profit over and above 4 percent on the money invested at the end of 50 years of over $5,000 which reinvested at 5 percent would yield an annual income for the schools of $250. If the town preferred it might invest the whole $5,000 in school buildings. Suppose another town with 100 acres of medium land should plant 10 acres every 5 years. In 50 years, when the last of the area had been planted for four years, the first one would be ready to cut and the town might have a periodic income from that time



Plantation of Scotch Pine three years after planting. Land of the University of Vermont, Burlington.



Usual method of planting with Mattocks. (The sugar snow is no great disadvantage).

of about $2,000 every 5 years. This, it must be remembered, is the profit over 4 percent compound interest on the whole investment. If a third town gradually acquired 500 acres for this purpose, and annually planted 10 acres for a period of 50 years, the future annual net income might easily be $2,000 if the soil was of medium quality, or $3,000 if it was of first class quality.

There are several classes of land which Vermont towns may be expected to use as school endowment forests.

(a) Many towns own lands surrounding their reservoirs which can not be cultivated for any length of time because they cannot be fertilized. A forest cover prevents evaporation, retards the melting of snow, and in other ways protects the water supply. Such land would be doubly useful if planted with forests, because they would in time yield a revenue.

(b) Occasionally tracts of cut-over forest lands are sold for taxes. Such lands are usually of third quality soil and are, therefore, less profitable for planting than more expensive lands. However, the town can afford to bid these in at a price which the private individual might not care to pay because of the indirect value to the town from having the land productive and the water supply protected. It should be remembered that a tax title is not very good and it is well to pay a little more for a quit claim deed.

(c) In many towns there are public spirited men who would be glad to endow the schools of their town either by outright gift of land or by willing such land to the town. It might be well for the town clerk in each town to canvass his town for such donations.

(d) In many towns there are abandoned farms which are practically non-productive, on which the taxes amount to very little. In many cases it would be good policy for the towns to buy some of these abandoned lands and reforest them. They would in that way become productive and would in time furnish more remunerative work to the people of the town than they ever will in their present condition, and because of this fact the population of the town can be increased.

The question of establishing a school endowment forest should be brought up before every town. The new law reads as follows:

NO. 24 OF THE ACTS OF 1912

AN ACT TO PROVIDE FOR SCHOOL ENDOWMENT FORESTS

It is hereby enacted by the General Assembly of the State of Vermont.

Section 1. Towns and cities may at any legal meeting grant and vote such sums of money as they may deem best for the purchase, management and improvement of lands for the purpose of growing wood and timber thereon.

Section 2. Any town or city having in its possession, either through donation, purchase or forfeiture for taxes, a tract of land of not less than forty acres, may have the same examined without cost by the state forester for the purpose of determining whether the same is suitable for a school endowment forest. If, upon examination, the state forester decides that it is suitable for such purposes, it shall be designated as a school endowment forest, and the state forester shall give advice as to what trees shall be planted thereon and as to the subsequent management thereof.

Sec. 3. The state forester is authorized to distribute annually 150,000 trees from the state nursery among towns for the planting of school endowment forests, said trees to be sold at the same prices as those to private individuals.

Sec. 4. School endowment forests shall be managed under the direction of the state forester, and only such trees may be cut as he may, from time to time, designate. The protection of the forest shall be under the town forest fire warden, who shall be compensated for his services by the town at the same rate as is paid for fighting forest fires, upon the approval of his account by the state forester.

Sec. 5. All money received for the sale of lumber, wood or other produce from a school endowment forest, shall be deposited with the treasurer of the town owning the same, who shall render an annual report of all money so received to the state treasurer.

Approved April 1, 1915.

APPENDIX

HEIGHT GROWTH

The best data available as to the height growth of the species recommended is included in the following table:

TABLE VIII

Height growth in feet of species recommended for planting.

Age in years	White pine[1]			Norway pine[2]	Balsam fir	White ash
	Upland pasture	Sandy soil	Wet swamp	Average[2]	Average[3]	Average[4]
10	9	5	4	12	..	..
20	24	23	16	35	14	39
30	40	36	28	58	25	53
40	53	44	39	70	36	63
50	64	51	48	77	45	71
60	73	57	54	82	52	77
70	80	61	60	85	59	82
80	84	65	65	88	64	86
90	89	..	70	90	68	90
100	91	..	..	91	71	93

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[1] Mass. State Forester, "Forest Mensuration of White Pine."
[2] U. S. For. Serv. Bul. 139 (1914), Bayfield Co. Wis.
[3] U. S. For. Serv. Bul. 55 (456 trees in Maine).
[4] Vt. Sta. Bul. 176 (1914). Vt. For. Serv. Pub. 13.

DIAMETER GROWTH

Diameter in inches of trees of different ages

TABLE IX

Age in years	White pine[1]		Norway pine[3]	Balsam fir[2]	White ash[4]
	Quality I	Quality III	Average	Average	Average
10	1.7	1.0	.6	...	...
20	4.0	2.3	2.8	1.2	4.1
30	6.4	3.9	5.7	2.7	6.1
40	8.6	5.5	8.0	4.1	7.9
50	10.8	7.0	9.9	5.5	9.5
60	12.8	8.6	11.7	6.7	10.8
70	14.7	10.1	13.2	7.9	11.8
80	16.5	11.7	14.6	8.9	12.6
90	18.2	13.2	15.9	9.9	13.3
100	19.8	14.5	16.9	10.7	13.8

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[1] Report of Forest Commissioner of N. H., 1905-06.
[2] U. S. Dept. Agr. Bul. 139 (1914).
[3] U. S. Dept. Agr. Bul. 55 (1914).
[4] Vt. Sta. Bul. 176 (1914). Vt. For. Serv. Pub. 13.

23.

STATE OF WISCONSIN

CONSERVATION COMMISSION

MADISON

[illegible]

JAMES NEVIN, **Chairman**

W. E. BARBER, F. B. MOODY,

R. S. SCHEIBEL, **Secretary**

FISHERIES

FORESTRY

STATE PARKS

FISH AND GAME PROTECTION

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FOREST PLANTING IN WISCONSIN

By

W. D. BARNARD, Forest Assistant

INTRODUCTION.

Raising timber in Wisconsin means increased prosperity and the maintenance of all the useful influences of forests. The importance of forest planting is now recognized throughout the timber states and results attained from older plantations in various states have been highly satisfactory. This pamphlet has been prepared because of the increasing interest in reforestation in Wisconsin and in order to meet the need of more specific information on the subject. Its scope is necessarily limited to planting of forests and does not extend to ornamental planting.

Raising merchantable timber is not the sole incentive in forest planting. Besides the valuable wood material produced, forests conserve soil moisture, thus regulating stream flow, they furnish a refuge for wild life and healthful recreation grounds. A plantation only 10 or 15 years old will contribute very largely to the beauty of a site, and will afford an excellent refuge for wild life. A forest does not need to be of merchantable age to be valuable.

WHAT THE STATE HAS DONE.

Forest planting in Wisconsin is yet in its infancy. Extensive planting did not begin until 1911, when nearly 200 acres of state lands near Trout lake were planted to conifers. As there were no state nurseries in Wisconsin at that time, the first planting stock was purchased from commercial nurseries. The same year, however, a nursery was established at Trout lake and about 1,000,000 seedlings were raised.

In 1912, 10 acres more of the state lands near Trout lake were set with conifers, and the nursery was enlarged to 7 acres. A nursery of 4 acres was also established at Tomahawk lake.

In the spring of 1913 some of the stock in the Trout lake nursery was large enough to set out, and operations were begun at Star lake and at Plum lake. Since that time the plantations on the state forest reserve have been increased to a total of about 900 acres, and in addition to this, more than 100 acres have been planted by landowners in various parts of the state, with stock from the state nurseries.

The state nurseries now produce about 1,000,000 trees annually. Much of this stock has been used on the state forest reserves. Some of it is being planted in state parks, and some of it is purchased by parties owning land in the state, which they wish to reforest. An increasing amount of the planting stock is being purchased annually for private planting, and it is certain that when the possibilities of forest planting are more fully realized, there will be a demand for as much stock as the state nurseries can furnish, or even more.

A SCOTCH PINE PLANTATION 23 YEARS OLD, MILBROOK, N. Y.

Average height 35′. Courtesy Forestry Dept., Cornell University.

NORWAY SPRUCE, WHITE PINE AND SCOTCH PINE PLANTED IN MIXTURE.

Forty years old. Grown from seed sown broadcast. Average height 55′. Courtesy Forestry Dept., Cornell University.

CONDITIONS THAT MAKE FOREST PLANTING ADVISABLE.

In Wisconsin, forest planting is usually advisable on lands of the following character:

Rough Land in Farms.

(1) Parts of farms which, because of their rough or rocky nature, thin or poor soil, inaccessibility, or other disadvantages, are suited only to forest growth. This class includes steep and rocky hillsides from which the top soil has eroded, gullies, borders of streams and the like, —land that will support good forest growth, but that produces little or no income when used for any other purpose.

Cut-over Land.

(2) Wild land from which all valuable forest growth has been removed, and which is unsuited for agriculture or is not yet needed for agriculture. Portions of the cut-over pine lands in the northern part of the state are a good example of this type.

Brush Land.

(3) Brush land such as abandoned fields and pastures, or other land that has grown up to worthless brush. Such land is bringing in no returns, but could be made valuable by planting desirable species of trees on it.

Timberland Incompletely Stocked.

(4) Timberland incompletely stocked, on which a full stand is desired, and which is not likely to be renewed by natural seeding.

Farm Woodlots.

(5) Farm woodlots which cannot be fully stocked within a reasonable time except by planting, or a treeless area to be added to the woodlot.

PREPARATION OF LAND.

Although a planting area often needs some preparation, it is rarely advisable to give the land the careful and expensive preparation such as is necessary for the growing of field crops. The treatment required depends entirely upon local conditions. In general, land planted with trees should be well protected from fire, grazing, or other agency that is likely to injure or retard the growth of the trees.

If the planting area has been logged and the slash has never been burned, it should in most cases be disposed of before any planting is attempted. If there is slash or other inflammable material on the ground, there is constant danger from fire unless the area is very small and is carefully guarded. Even under these conditions it is usually much the safer plan to dispose of the slash before planting.

Dead timber should, when practicable, be removed from the land to be planted. Dead and dying timber is not only very unsightly, but is likely to fall, injuring the young growth, and increasing the danger from fire. It also invites and harbors many species of insects, which may be very injurious to young growth.

TIME TO PLANT.

Spring Planting.

The best time for forest planting is in the early spring, as soon as the frost is out of the ground. The trees are then dormant. They will be damaged less by handling then than after the buds have swelled or the tender young shoots have started. If the buds and shoots are damaged, the trees will be deformed. This is especially true of conifers. After planting, the spring rains will further settle the soil about the tree roots and ideal growing conditions usually follow the disappearance of frost from the ground.

Late spring planting should be avoided. Not only does it do great damage to the trees, but the transferring of the trees stops root functions and root development at a time when they should be taking food from the ground. It checks the growth of the trees until they have become reëstablished in the ground. Trees planted late in the spring frequently do not become well established during the first season, and they may not thereafter begin a rapid growth on the new site for two and even three seasons.

Another factor that causes much loss in late spring planting is the loss of moisture from the leaves of the trees. This occurs in both broadleaf and coniferous species. When leaves are on the trees and the trees are active, there is a constant giving off of moisture from them. If during this time, the trees are disturbed so that the roots cannot take up a corresponding amount of moisture, the plants will die. In the late spring this evaporation of moisture from the leaves is increased by higher temperatures, and consequently there is likely to be a great loss of young plants.

Fall Planting.

Fall planting should not generally be practiced when it is possible to do the work in early spring. In spring the trees can adapt themselves to the new conditions immediately, but in the fall they will not become entirely adapted to the new conditions until growth begins the following year. Fall planting exposes the trees to injury, during the winter, from various agencies. Under no circumstances should fall planting be attempted on heavy clay soil.

Fall planting has been done, however, in a number of cases with a marked degree of success. In the state nursery at Trout lake, fall transplanting of conifers has been practiced for a number of years, and from the appearance of the trees, the work done in the fall cannot be distinguished from the work of the following spring. In the fall of 1914, 10 acres near Trout lake were planted to white, Scotch, and red pine. Another plot of 2 acres was planted to Norway spruce. The plantings of trees with compact, fibrous roots and small tops, namely white pines and Norway spruces, were very successful, between 85 per cent and 90 per cent having survived. In the case of the red and Scotch pines, which had large tops and less compact roots, the results were much less favorable, there being a survival of only 54 per cent. This was probably because there was an evaporation from the tops of more moisture than the small root system could replace.

Broadleaf deciduous species should not be transplanted while the leaves are on the trees. Fall planting of broadleaves is generally more successful than that of conifers. This is due to the fact that in fall planting, moisture may be lost from the leaves of conifers at a time when the roots have no means of compensating for this loss. While the loss of moisture at this time of year is not so great as when growth is taking place, yet there is always a small amount of evaporation from the leaves of coniferous trees. With broadleaves, evaporation in the fall of the year takes place only from the bark, and is comparatively slight.

SELECTION OF SPECIES.

Purpose of Planting.

The selection of species for planting is necessarily governed by a number of factors. The first of these factors is the purpose for which the timber is wanted. Many of the shade and ornamental species are of little value for commercial planting. Similarly, many species that are valuable for certain commercial purposes are of little or no value for others. It is therefore practicable to plant species which, when large enough for use, meet the given requirements.

Character of Site.

Another factor is the character of the site. Although certain species may be desired, it will often be necessary to plant others, for the reason that the first may not be suited to local conditions. Species that demand good soil should not be planted on a poorer one. Neither should shade demanding species be planted on exposed situations. An inferior species should not be planted on a site where a more valuable one would thrive and yield greater returns. Species should be chosen that are well adapted to a site, and that will produce the most valuable material within a reasonable time.

Another guide in the choice of species that are likely to be profitable on a given site is the original forest growth. The species formerly occupying the land can be determined by examination of stumps or by observing the growth on nearby sites that are similar.

Rate of Growth.

The rate of tree growth is an important factor in selecting species. Species that will grow rapidly and that will produce valuable material in the shortest time are the ones to plant. Under normal conditions and on average sites, pines should produce under proper management not less than 25,000 board feet per acre at the end of 50 years. Broadleaf species produce less lumber per acre than pines of the same age but yield more cordwood. Data relative to tree growth will be found on page 19 and will serve as a guide in the selection of species.

Species Suited to Various Uses.

As the characteristics of tree species vary, the demand for and uses of the wood also vary. Table 1 gives some important forest trees that may be profitably planted in Wisconsin for ordinary uses.

NORWAY SPRUCE PLANTATION—18 YEARS OLD. MILBROOK, N. Y
Courtesy of Forestry Dept., Cornell University.

INTERIOR VIEW OF ABOVE PLANTATION.
Average height 30′. Courtesy, Forestry Dept., Cornell University.

Table 1. Species Suited to Various Uses.

Bolts	Lumber	Pulp	Poles & Posts	Ties
Basswood Butternut Maple Oak Poplar Willow	Larch Pine Spruce Ash Basswood Butternut Maple	Larch Pine Spruce Basswood Poplar Cottonwood	Larch Black locust Red oak	Larch Black locust Red oak

Soil Requirements of Certain Species.

The following table gives a list of some of the more important forest trees and the minimum soil requirements of each; that is, the poorest types of soil on which the given species are likely to be profitable.

Table 2. Soil Requirements of Certain Species.*

Light Sand	Gravel	Sandy Loam	Loam	Heavy Soil
Jack pine Scotch pine Red pine	White pine Red pine Scotch pine	White pine Red pine Norway spruce Red oak White oak Maple Cottonwood	White spruce Norway spruce Larch Butternut Basswood Maple Ash	Hickory Ash Walnut Basswood

*See also pp. 23 to 33 of this bulletin.

Special Considerations.

For extensive planting, conifers are desirable. They are inexpensive to plant, and in addition to their value as timber trees, they are good for windbreaks and are useful for preventing soil erosion. Broadleaf trees are also valuable for preventing erosion, and are suited to many purposes and situations to which conifers are not.

Whether conifers or hardwoods are planted, it is often practicable, when the work is carried on extensively, to plant in mixtures rather than in pure stands. When one species may not be adapted to a given site, another species, if planted with the first, may bring about a condition under which both will reach their best development. Moreover, one species may be subject to attacks by certain fungous diseases or by certain insects, and if planted in pure stands, an attack might damage the whole plantation; but if the species is alternated with another in a plantation, it will be more scattered, and the second species will probably not be subject to attacks of the same kind. Therefore, a plantation with a mixture of species may thrive better than a pure stand.

PLANTING INSTRUCTIONS.

SELECTION OF STOCK.

Conifers.

There is a general idea that large planting stock should be used to produce a good forest. This idea is erroneous, for with large trees the cost of planting is not only multiplied several times, but the percentage of loss is greatly increased. Conifers, on the whole, develop shallow, fibrous roots. A conifer 3 or 4 feet high will have a comparatively small and shallow root system unless it has been transplanted a number of times, and this operation is so expensive that such trees can rarely be used for purposes other than ornamental planting. Furthermore, the tops of conifers cannot be pruned to correspond with the removal of a part of the root system as can the tops of broadleaf species, as pruning a conifer destroys the form desirable in forest trees. In general, it is much the better plan to use stock not more than 12 inches high for plantations of conifers. The trees should be nursery grown, once transplanted, and should be 3 or 4 years old. Nursery grown transplants have compact, fibrous roots, and are much more likely to succeed under adverse conditions than are seedlings, either wild stock or nursery grown trees. To those who are familiar with nursery stock of broadleaf species only, conifers may be disappointing. Until about four years old, conifers grow slowly, averaging less than 6 inches a year. Broadleaf seedlings often grow from 10 to 20 inches a year.

Broadleaves.

With most broadleaf species, one-year seedlings and in some cases two-year old trees are of convenient size for planting. Unlike the conifers, these seedlings have well-developed roots, although they are not usually very fibrous. In the case of the oaks, walnuts, and hickories, which develop long taproots, the roots often need pruning to about two-thirds of their original length, and in planting, holes should be made of sufficient depth to receive them in a natural position. Forests of these species may be started by planting nuts or acorns directly on the site. Forest grown seedlings of broadleaf species can often be secured, and are very likely to succeed in the plantations.

TOOLS.

Before any planting is attempted, adequate equipment should be provided. Pails will be necessary for carrying the trees as they are being planted, and either grub hoes or spades will be needed for making the holes. Sixteen-quart galvanized iron pails are inexpensive, durable and light in weight and will contain as many trees as a planter can easily carry. Spades may be used where the soil is easily worked, but where sod, roots and rocks are encountered, grub hoes or mattocks are much better.

HEELING IN.

When the trees arrive at the planting site, they should be taken from the containers and "heeled in" until ready to be set out. Heeling in consists of plowing or digging a trench or series of adjacent trenches, in which the roots of the trees are placed, and then covered with moist earth, the covering extending up over the lower stems. If the trees are in bundles, the strings should be cut and the trees evenly distributed along the trenches. If a series of trenches is required, the soil taken from one trench can be used to cover the roots of the trees in the trench immediately preceding, thereby saving labor. The trenches should be in a shady place when possible, and should be so dug that the tops of the heeled trees will be inclined slightly toward the south. The trees in heel should not be allowed to dry out. To prevent this, a light covering of boughs or coarse hay is excellent, but the covering should not be so dense that it will cause the trees to mildew.

THE CREW AND ITS ORGANIZATION.

In all the planting operations on state lands, it has been found the best policy to have the crew work in pairs, one man making the holes and the other setting the trees in the ground. In addition to the men engaged in the actual work of planting, a supervisor or foreman is needed for each crew of ten or twelve men. The foreman sees that the lines are kept as straight as possible, and that the men are supplied with trees and water. Usually the foreman needs one or two other men or boys to keep the planters supplied with trees.

SPACING.

The keeping the rows straight, spacing at the proper distance and watching closely the actual planting, will occupy much of the foreman's time. The rows can best be kept straight by means of two flags, in line, which will guide the man who is taking the lead on the inside row. Each man who is digging holes keeps at the proper distance from the man next to the planted area, and judges the spacing for the holes in his row as he proceeds.

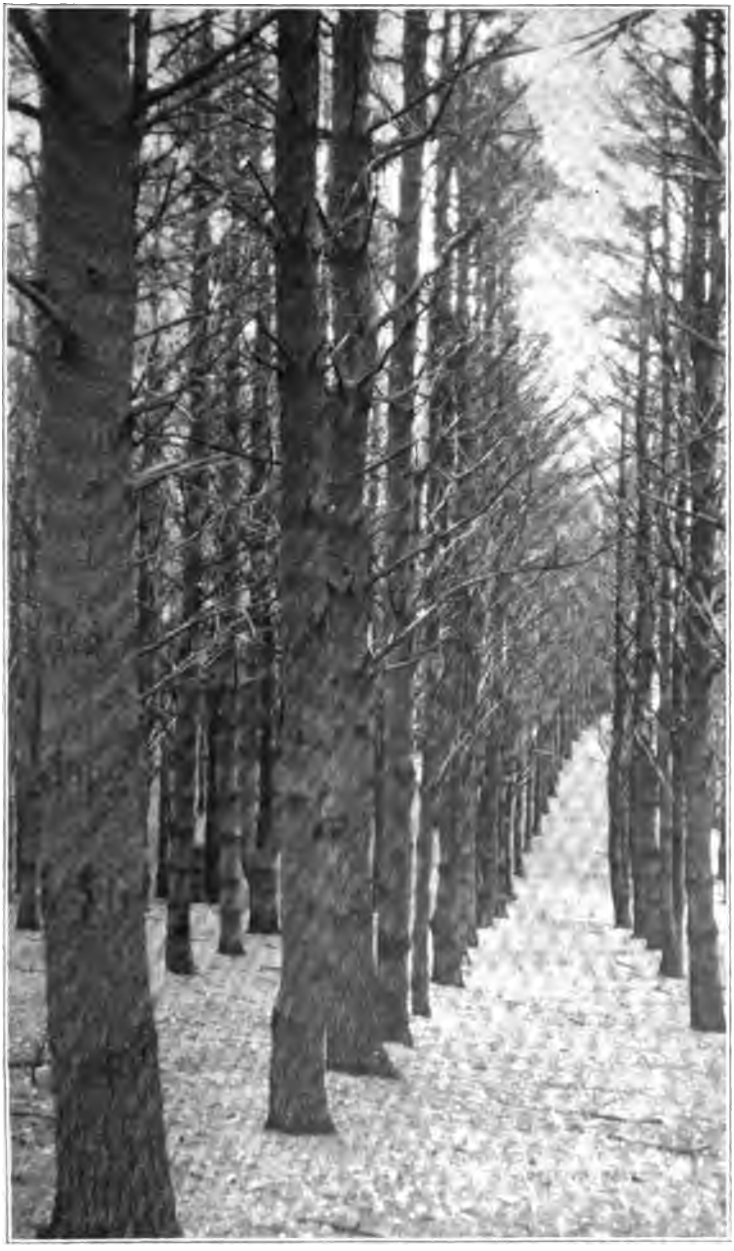
If the nature of the work is such that the rows should be straight and the spacing exact, it will be a great advantage to have several line stakes for each row of trees, and to have stakes or other marks to govern spacing in the rows. In extensive planting, however, it is far more important to have the trees carefully planted than to have them spaced at precisely the same distance. Such careful spacing requires much additional time and expense which is not generally warranted.

Table 3. The number of trees that may be planted on an acre of ground with a given spacing. (Rectangular planting.)

Spacing	No trees per acre	Spacing	No. trees per acre
3 x 3 feet	4,840	6 x 6 feet	1,210
4 x 4 feet	2,722	7 x 7 feet	889
5 x 5 feet	1,742	8 x 8 feet	680

There are many factors governing the proper distance to space trees in a plantation. Individual requirements will to some extent determine

A 55 YEAR OLD PLANTATION OF WHITE PINE IN MASS.
Average height 50′. Total board feet per acre 43,790. Courtesy of Mass Forestry Dept.



A VIEW OF THE SAME TRACT, TAKEN INSIDE THE WOOD.

Courtesy Mass. Forestry Dept.

the distance. If species that are tolerant of shade are planted, the spacing may be much closer than if intolerant species are used. Six feet apart each way is considered an economic and suitable spacing for most conifers, for with this spacing the final stand will need very little replanting if conditions are reasonably favorable.

METHODS OF PLANTING.

The actual work of planting a tree is comparatively simple and quickly done. It is, however, very important that great care be taken in doing it. The trees should be carried in pails containing sufficient water to keep the roots moist at all times. Puddling is not recommended.* The men with the implements should make the holes of sufficient size to receive the roots of the trees in a natural position. In making the holes, all sod and litter are scraped away, exposing about a square foot of the mineral soil. The soil is then pulverized, and the loose earth from each hole is left in a small mound close to it, where it can be easily used by the planters. In plantations where the time and additional expense can be permitted, the bottom of each hole should be made to conform to the root system of the various species. With flat-rooted species such as spruce, a small mound may be made in the center of each hole, and the roots spread out evenly upon it, so they will be in their normal position. The soil is then firmed about the roots, and when the hole is filled, the tree should be slightly deeper than when in the nursery, Speed in planting is developed by reducing motions to the minimum and by careful supervision.

It is much better for the trees to spread the roots in the manner described above, but when extensive planting is done, the practicability of such a method except with large stock is questionable. With careful supervision, planters can place the roots of small trees in a natural position by simply holding the trees in the left hand and carefully tamping the soil into the holes with the right. The soil having been replaced in the hole, the planter firms the surface with hands or feet and proceeds to the next hole, where the process is repeated.

Frequently the roots of conifers are of uneven length, and a few of the roots are much longer than the main ones. In such cases it is better to cut the long, straggling roots to about the length of the main roots rather than to twist or misplace them when setting the trees in the ground. When necessary, trimming of the roots can best be accomplished when the trees are in bundles at the nursery or at the time of heeling in. It may be done by placing the roots on a block and cutting the ends of the long ones with a sharp axe or hatchet. Care must be taken not to cut the roots so short as to injure the trees. Unnecessary trimming is to be avoided.

On sites where there is a great deal of sod and where roots and rocks will not interfere with plowing, planting in furrows will be productive of excellent results. Single furrows may be plowed where the rows are to be planted, and the holes for the trees made at the proper distance apart in the furrows. On steep land furrowing should be avoided or the furrows should be run along the contour of the hill, with interruptions by turning back the sod between plants.

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*"Puddling" the roots by dipping them into a puddle of thin mud was formerly thought advantageous, but this practice is now condemned on the ground that it mats the roots together, and does not allow their being planted in a natural position.

In addition to the methods just described, which are modifications of the hole method, there are a number of less desirable methods to be distinguished. Most of these, however, are designed solely to hasten the work of planting with little or no regard for the quality of the work or for its final results. One of these methods is known as the slit method. It consists simply of making a vertical slit in the ground with a spade, suspending the roots of the tree in the slit, and closing the opening with the heel or with the planting tool. This method should never be used except with very small stock, as it crowds the roots into a small space.

When grub hoes are used for planting, the slit method can be modified by driving the blade of the hoe into the ground, giving the handle a slight turn to either the right or the left, and pushing it backward so as to open a hole at the end and edge of the blade. This operation leaves a hole large enough for the roots of most seedlings and small transplants of conifers, and the planter needs only to place the roots in the holes, withdraw the mattock and to press the soil around the roots with the hand or with the heel. The method is not so slow as the hole method, and if the work is done properly, it will be found a very good and inexpensive method of planting small conifers on soils where it can be used.

CARE IN HANDLING TREES.

In planting young trees the greatest care should be exercised to prevent the drying out of the roots, and to plant the trees with the roots at the proper depth and in the proper position. Conifers are especially susceptible to drying out of the roots, but broadleaf species should also be handled very carefully. Trees are more likely to make a very poor growth if the roots are matted, crowded, or otherwise misshapen when planted, and on sites where moisture is less abundant, greater losses may result. Trees so planted may grow well for a number of years and then die for lack of food.

If the roots become dry the trees are almost certain to die during the first year; poor planting will usually result in the death of the trees a few years after setting; but the ultimate result will be the same in each case, namely, a failure.

CARE OF PLANTATIONS.

Forest plantations require very little care during the first few years. If the trees are spaced at 6 feet, no thinning is likely to be required for at least 15 or 20 years. If 60 per cent of the trees planted survive, no filling of blanks will be necessary unless fail places are very large or unless a dense stand is desired.

In old fields the formation of sod menaces the young trees, and this may be checked by removing the sod on a space one foot square where each tree is to be set.

Insects and fungous diseases sometimes attack young forest trees. Both have in some cases been serious, but great damage from either source is comparatively rare. Birds are very effective in the control of insects, and should be given protection at all times. If insects or fungous diseases appear to do any serious damage, it would be well to apply to the state for aid and advice.

PROTECTION FROM FIRE AND GRAZING.

Fire is more destructive to the forest than any other agent. A small fire that would not seriously damage mature timber may kill young growth. It is very necessary that fires be kept out of planted areas, or other land supporting valuable forest growth. A method of fire prevention must be determined for each individual area.

In the protection of an area from fire, it is first necessary to have the area accessible. If it is large, it should have a number of fire lanes or roads traversing it. Fire lanes when properly constructed can be used for roads, at least in cases of emergency. The location of fire lanes and roads will depend upon the size, location and topography of the area to be protected. Roads and fire lanes are useful first, in making an area accessible; second, in providing firebreaks which may stop fires, or at which a crew of men may stop fires, and third, in providing lines from which back fires may be started.

When an area has been made accessible by an adequate number of roads and fire lanes, the protection depends largely upon the care with which the area is guarded in dangerous seasons. A small fire if discovered in time may be easily extinguished, but if neglected for even a short time, may do great damage. It is of the utmost importance that fires be discovered and extinguished before they have gained any headway.

Fires should be attacked from the front when possible. Small fires can usually be extinguished with sand. Sand and water are also very effective in checking larger fires. Large fires usually require backfiring. A backfire which can be easily controlled, may be started from a road or fire lane toward the main fire, when it would be impossible to get near the main fire to attack it, and the main fire will die out when it reaches the belt burned over by the backfire. The greatest care should be exercised after a fire has been apparently extinguished to see that it is not fanned into new activity by a wind.

Forests should be protected not only from fire, but from other destructive agencies. Grazing stock is very destructive to young growth especially in small areas such as farm woodlots. Stock not only browse upon young trees, especially broadleaf deciduous species, but they trample upon and kill or deform them. The best yield can be obtained from the forest when it is not used for pasture.

COST OF PLANTING.

The cost of forest planting is extremely variable. This is especially true when small areas are planted, or when extensive operations are attempted by those unfamiliar with the work. The factors that influence the cost are (1) accessibility of the planting site, (2) the amount and nature of ground cover and litter on the site, (3) the kind of soil, (4) the source and size of the planting stock, (5) method of planting, and (6) the supervision of the planting crew.

Cost per Acre.

The cost of planting on state lands has been from $7 to $10 per acre, including the cost of the trees, planting, and all incidental expenses. It is the intention to keep this cost at not more than $8 per acre on an average, but in some instances it will necessarily be higher. The table below gives the itemized cost of some of the work done on state lands in the spring of 1914. In this work, an average of 1,000 trees was planted to the acre.

Table 4. Cost of Planting per Acre.

Trees	Transportation	Surveying	Planting	Equipment	Supervision	Total per acre	Total area (acres)
$2.50	$.01	$.18	$2.66	$.07	$.32	$5.74	10
3.00	.02	.12	3.19	.08	.38	6.79	40
4.00	.01	.18	2.66	.07	.38	7.30	10
2.50	.29	.17	2.08	.13	.09	5.26	35
2.00	.35	.22	3.11	.11	.05	6.84	20

The cost of planting in a number of other states varies from $6 to $15 per acre, with an average of perhaps $10. In Wisconsin, the average cost, including all expenses, is somewhat less than this average, or about $8 per acre. The cost of private planting varies between $8 and $10 per acre, if the site is favorable, if the stock can be bought at a reasonable price, and if competent men can be secured to superintend the work.

Financial Returns.

Whether forest planting should be undertaken depends largely upon the financial returns that may be reasonably expected. As forest planting was so recently begun in Wisconsin, no cost figures are at present available. Assuming that this cost does not vary appreciably from the cost in other states, planting in Wisconsin will net fair returns.

The following table shows the cost of raising white pine in New England and gives the value of the pine at different ages:

Table 5. White Pine in New England*—Per Acre.

Age yrs.	Land and Planting[1]	Administration and Protection[2]	Taxes	Total Cost	Size in.	Yield M. ft.	Cost per M.[3]	Stumpage value per M.
40	$45.01	$4.75	$9.50	$59.26	6.7	20	$2.96	$5.00
50	68.07	7.63	26.43	102.13	9.0	30	3.40	6.00
60	102.20	11.90	61.09	175.19	10.7	38	4.61	7.00
70	152.72	18.21	122.71	293.64	12.0	45	6.53	8.00
80	227.50	27.56	225.19	480.25	12.9	50	9.61	9.00
90	338.19	41.40	387.67	767.26	14.5	55	13.95	10.00

[1] Land and planting, $10.00 per acre.
[2] Administration and protection, 5c per acre.
[3] Interest compounded annually at 4 per cent.
*The Cost of Growing Timber, R. S. Kellogg and E. A. Ziegler, American Lumberman, Chicago, 1911.

Table 5 shows the profit that may be expected from white pine plantations under reasonably favorable conditions. In most plantations on which reports have been made, the maximum profit may be realized when the plantations are 50 years old. A net profit of 6 per cent interest, compounded annually, is common.

PLANTING VS. DIRECT SEEDING.

Since reforestation began on state land in 1911, numerous inquiries have been received as to why it is better to sow the seed in the nursery, to incur the expense of caring for the nursery stock for 3 or 4 years, and then to add the expense of planting the trees, than it is to sow the seed on the area to be reforested. At first thought the nursery might seem to be a very expensive and unnecessary step in the growing of forest trees.

Direct seeding may be productive of good results if conditions are exceptionablly favorable but ordinarily the method is expensive and impracticable. In direct seeding, whether by broadcast sowing or by the seed-spot method, no less than 5 pounds of coniferous seed is required for an acre of ground. The initial cost of the seed would therefore be not less than $8 or $10. Adding to this amount the necessary expense of preparing the ground, sowing the seed, and subsequently dragging or harrowing, the total cost per acre would be about $15, which is almost twice the cost of planting with first-class nursery stock.

Not only is the cost of direct seeding excessive, but the results are usually very poor. Birds and rodents eat large quantities of the seed, and a few days of hot, dry weather when the remainder of the good seed is germinating, is sufficient to kill almost all of the tender, unprotected seedlings. In the nursery the seed and seedlings are properly cared for, and a pound of good coniferous seed will produce from 10,000 to 25,000 seedlings, according to the species.

Broadleaf species that bear seed of good germinating quality can often be successfully grown by planting the seed in the field. The seed-spot method is recommended in such cases. The soil in plots of about one foot square is pulverized, and the seed is placed in the pulverized soil at the proper depth. The oaks and other nut-bearing species usually, with this method of planting, give the best results, but whatever species are used, the seed should be of good germinating quality and the locality should be comparatively free from rodents that are likely to destroy the seed. Only a few seeds are required for one seed spot, and the seed spots may be spaced at whatever distance the owner of the land prefers; but ordinarily the spacing is from 6 to 8 feet each way.

It is a fact that many areas reseed naturally, but where an area has been burned over repeatedly, there is little or none of the natural reproduction left. Therefore, if such areas are to be made productive of good forest growth, artificial regeneration must be practiced.

RATE OF TREE GROWTH.

Different species vary greatly in the rate of growth, and trees of the same species will vary greatly in the rate of growth on different sites.

Table 6. Rate of Growth of Forest Trees.

Very Rapid	Rapid	Moderate	Slow
Black locust	Scotch pine	Jack pine	Cedar
Poplar	White pine	Red pine	Red spruce
Cottonwood	Basswood	Scotch pine	Hickory
Willow	Elm	Norway spruce	Maple
		Larch	Pin oak
		Ash	White oak
		Butternut	
		Elm	
		Red oak	

Table 7. Diameter and Height Growth.*

Species	Age 30 years.		Age 50 years.		Age 80 years.		Age 100 years.	
	Diam. in.	Height ft.	Diam. in.	Height ft.	Diam. in.	Height ft.	Diam. in.	Height ft.
White pine[1]	5.8	42	10.6	60	16.6	82	20	92
Red pine[1]	5.8	45	10.3	75	15.3	90	17.6	95
European larch[2]	8.8	45	......	......	......	......	......	......
Red oak[3]	7.6	56	12.4	76	16.4	86	......	......
White ash[4]	7.8	67	12.1	90	17.5	103	20.3	106

[1] Data obtained in northern forests.
[2] Farm plantations in Illinois; figures would be lower for forest grown trees.
[3] Data secured in Central Hardwood region; figures would be somewhat lower in the northern states.
[4] Data from the southern forests; figures would be somewhat lower in the northern states.
*Compiled from The Woodsman's Handbook, Bulletin 36, U. S. Forest Service.

The Yield of Some Plantations.

The following figures give the yield of some plantations in New York state growing on non-agricultural lands:

1. *White pine (small per cent other species)........44 years old, 38,000 ft. B. M.
2. *Norway spruce and Scotch pine........40 years old, 26,000 ft. B. M.
3. *Scotch pine........35 years old, 27,000 ft. B. M.
4. †White pine........31 years old, 18,500 ft. B. M.
5. *White pine........28 years old, 24,000 ft. B. M.
6. †Scotch pine and European larch........25 years old, 13,000 ft. B. M.
7. †Norway spruce........22 years old, 10,000 ft. B. M.

*First quality site.
†Third quality site.

PRIVATE PLANTING IN THE STATE.

COÖPERATION OF STATE.

It is the policy of the Conservation Commission to encourage private forest planting throughout the state, and to render assistance to landowners who engage in the work. This aid to planters is of four kinds: first, the sale of planting stock from the state nurseries at a reasonable figure; second, the giving of advice and aid by correspondence; third, the examination of tracts and making of planting plans by competent foresters at actual cost to the state; fourth, the superintending of planting operations by foresters at actual cost to the state.

A 39 YEAR OLD PLANTATION OF WHITE PINE.
Bridgewater, Mass. Courtesy Mass. Forestry Dept.

Planting Stock from State Nurseries.

Each year, the state forest nurseries furnish a considerable amount of planting stock for private planting. This stock is grown in the northern part of the state from carefully selected seed, and hence is very hardy, although somewhat smaller than trees of the same age grown in warmer climates where there is a longer growing season.

Following is a price list of trees that may be secured from the state nurseries. It is not always possible to furnish all the stock listed, and sometimes stock is available that is not listed here.

Table 8. Prices of Nursery Stock, F. O. B. Nursery.

Species[1]	Age Class[2]	Price per 1,000[3]
White pine	2-yr. seedlings 3-yr. transplants 4-yr. transplants	$1.50 3.50 4.00
Red pine	2-yr. seedlings 3-yr. transplants	1.50 3.50
Scotch pine	2-yr. seedlings 3-yr. transplants	1.50 3.50
White spruce	3-yr. transplants 4-yr. transplants	3.50 4.00
Norway spruce	3-yr. transplants 4-yr. transplants	3.50 4.00
White ash	2-yr. seedlings	1.50
Basswood	1-yr. seedlings	3.00
Red oak	2-yr. seedlings	2.00

[1] Additional lists and application blanks may be secured from the State Conservation commission upon request.

[2] Three year transplants of conifers are trees that have been in seed beds two years and in the transplant beds one year, making a total of three years.

[3] No orders filled for less than 100 trees of any one species. On orders of less than 1,000 trees, the price is computed at the regular rate plus 50c extra for packing.

NOTE. The state nurseries do not come into competition with commercial nurseries. No stock is sold for ornamental planting and no large sized stock is sold. The cost of starting forest plantations with the stock ordinarily put out by commercial nurseries would be prohibitive. Therefore, the state, in view of the public benefits to be secured by forest planting, has made planting stock available for use within the state, at a low price.

Giving of Advice and Help by Correspondence.

If a landowner desires advice and help in connection with a prospective planting operation, he should address a request to the State Conservation commission, giving full information in regard to the land to be planted and the particular purpose for which it is to be planted. Such advice and help as it is possible to give him without putting him to the expense of examining his land, will be given by correspondence.

Examination of Areas by Foresters.

When a planting operation of sufficient importance to warrant the expense is to be undertaken, the state will send a forester to look over the tract and make a planting plan and estimate of cost, at the expense of the owner and at cost to the state. If applications for the examination of tracts can be listed early, so that a forester can visit several on a single

PLANTING CREW AT WORK ON CUT-OVER LANDS.

The cost of planting is about $8.00 per acre on land of this type.

A PORTION OF THE STATE FOREST NURSERY AT TROUT LAKE.

Transplant beds in the foreground; seed beds in the background. The total area of this nursery is 7 acres. Annual capacity 1,000,000 trees.

trip, the expense will be considerably reduced. Before an examination is applied for, the landowner should send detailed description of his tract and all possible information.

Supervision of Planting.

When planting is done on an extensive scale, it is often possible to have a forester superintend the work, or superintend the beginning of it at least. In this case, as in the examination of tracts for planting, the owner incurs the expense of the forester's services.

PRIVATE PLANTATIONS STARTED.

The interest in forest planting has increased yearly, since the state adopted the policy of encouraging tree planting. The following figures give the number of plants set out on private lands by years:

1914—20,200
1915—77,400
1916—Applications had been listed up to Feb. 1, for about 250,000.

The following organizations and individuals have taken advantage of the opportunities offered by the state and have planted trees on their lands:

1914

Name	*Address*	*No. of trees planted*
W. H. Bradley	Minocqua, Wis.	500
P. N. Burg	Shell Lake, Wis.	400
I. G. Crowell	Shell Lake, Wis.	1,000
Delta Land Co.	Trempealeau, Wis.	10,000
Florence Iron Co.	Florence, Wis.	6,000
R. J. Nye	Superior, Wis.	1,000
Washington County Asylum	West Bend, Wis.	1,300
		20,200

1915

Mrs. Max Adler	Minocqua, Wis.	500
V. P. Atwell	Stevens Point, Wis.	3,200
O. C. Doering	*Chicago, Ill.	3,000
Jerry Donohue	Sheboygan, Wis.	14,000
Florence Iron Co.	Florence, Wis.	3,000
R. C. Heinz	*Leavenworth, Kan.	400
Jos. Kemp	Woodford, Wis.	1,000
R. J. Nye	Superior, Wis.	3,000
Percy Ap Roberts	River Falls, Wis.	300
C. A. Tilt	Woodruff, Wis.	200
E. M. Weaver	Woodruff, Wis.	250
W. R. Wilmont	Sayner, Wis.	500
Everett Wilson	*Winnetka, Ill.	48,000
		77,450

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*These trees were planted in northern Wisconsin.

SILVICAL NOTES ON SOME IMPORTANT SPECIES.*

WHITE PINE (*Pinus strobus*).

White pine is widely distributed throughout the northeastern Unite States, and is the largest and most valuable of the eastern conifers. I is more or less abundant over the entire state of Wisconsin.

White pine prefers fresh, well-drained sites, although it is not very exacting in its requirements. It does not succeed well, however, on dry and exposed situations. It is moderately tolerant of shade until 40 or 50 year old, when it becomes rather intolerant. It is an excellent tree for plantin in most parts of the state, and grows rapidly, either in mixture or in pur stands.

It grows to a merchantable size, that is, a size that can be cut profitably, in 50 to 75 years, when it may be expected to produce from 30,00 to 40,000 board feet per acre.

For planting, 3 or 4-year transplants should be used, and should b spaced 6 by 6 feet.

RED OR NORWAY PINE (*Pinus resinosa*).

Red pine is common in the northeastern United States, although i reaches its best development in northern Michigan, Wisconsin and Minnesota.

It grows best on well-drained, sandy loam soil, but it also thrives o poor sands. It grows rapidly and suffers little from fire, insects or disease. It is intolerant of shade at all ages, and therefore should b planted in pure stands or with slower growing species. It may be successfully planted in all parts of the state, especially on the northern piner lands. 3-year transplants are the best size for planting, and should b spaced 6 by 6 feet. Red pine develops strong lateral roots, and is ver windfirm when planted on exposed sites.

JACK PINE (*Pinus divaricata*).

Jack pine is found principally on sterile, sandy soils. It grows rapidl until 25 or 30 years old, but never becomes a large tree. It reproduce well, especially after fires, as the cones containing the seed remain on th trees for years, often until opened by the heat from fires.

Of this species, 2-year seedlings or 3-year transplants may be planted but on account of the inferiority of the timber, planting is rarely advisabl when red or Scotch pine can be planted. The latter species grow wel on poor sites, and are much more valuable when mature than jack pine.

SCOTCH PINE (*Pinus sylvestris*).

Scotch pine is native over a large part of Europe, and is being plante extensively in this country. As a timber tree, it is very similar to ou native red pine but is somewhat inferior in quality, although much bette than jack pine. Thus far it has not become of commercial importanc in this country.

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*Forest planting leaflets for various species can be obtained usually from th Forest Service, Washington, D. C., and can be purchased from the Superintenden of Documents, Washington, D. C., for 5 cents each.

Scotch pine grows well on sterile, sandy soils, and being very hardy, it is a good species to plant on exposed situations. It is very intolerant of shade, but grows rapidly when exposed to sunlight. Seedlings 2 years old or transplants 3 years old should be planted with a spacing of 6 by 6 feet. Scotch pine attains a merchantable size in from 40 to 50 years.

TAMARACK (*Larix laricina*).

Tamarack is the only deciduous conifer native to Wisconsin. It has a wide range, including practically all of the state. It commonly grows along the borders of swamps and the banks of streams, but reaches its best development on moist uplands. It is not recommended for extensive planting because of the inferior quality of the wood as compared with many other species, the small size of mature trees, and the attacks that are sometimes made upon it by the sawfly.

It grows rather rapidly, but being very intolerant of shade it does not do well except in the open. It reaches a height of about 70 feet.

EUROPEAN LARCH (*Larix europaea*).

European larch is very similar to our native tamarack. Unlike the tamarack, larch does not grow in swamps, but prefers a well drained but reasonably moist site. It is very intolerant of shade, but as it grows rapidly it can be planted in mixture with species that it will outstrip. It grows best on northern slopes, where in its native soil it often reaches a height of 100 feet.

The wood is resinous, and is excellent for ties, posts, and poles. It is also used in boat building.

For planting, either 2-year seedlings or transplants of the same age are recommended. Like the tamarack, the larch is deciduous, and should be planted early before the leaves begin to grow or in the fall.

BLACK SPRUCE (*Picea mariana*).

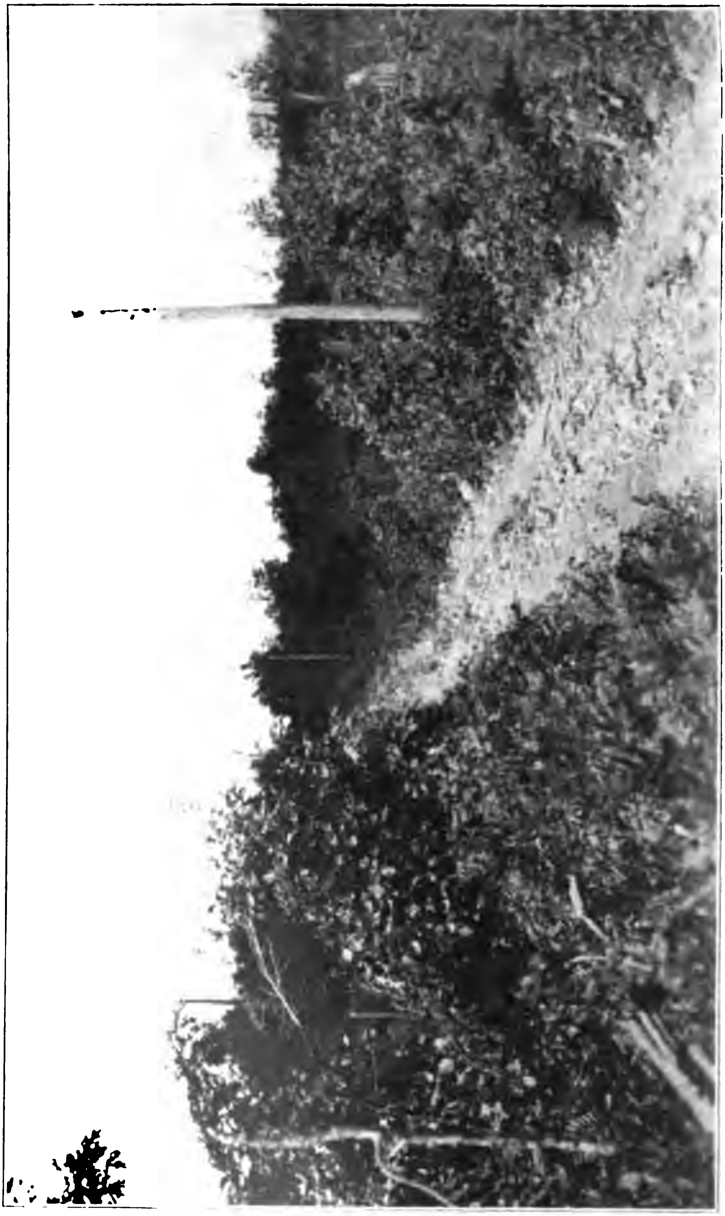
Black spruce is a small tree, typical of sphagnum swamps in Canada and the northern United States. It is an extremely slow growing tree, especially on the uplands, and is not recommended for planting. This species is sought after for pulp and for Christmas trees.

RED SPRUCE (*Picea rubens*).

Red spruce is found in the northeastern United States, but its natural range does not extend as far west as Wisconsin. In many respects it is similar to black spruce, but instead of growing in swamps, it grows on moist hillsides, where it forms very dense stands. It grows slowly, which makes it an undesirable tree for any but ornamental planting.

WHITE SPRUCE (*Picea canadensis*).

White spruce is native to Wisconsin and grows on the better classes of soils. It grows on moist uplands, rarely if ever being found in the swamps. It is the common upland spruce of the lake states.



It grows reasonably fast and while it has not become of great importance in reforestation, there is every reason to believe that it will rival the Norway spruce in growth and quality of lumber, if planted on favorable sites. The 3 or 4-year transplants should be used for planting, and as the tree is very tolerant of shade, it may be spaced 5 by 5 feet, if desired.

NORWAY SPRUCE (*Picea excelsa*).

Norway spruce is native to Europe where it is greatly in demand for pulp and lumber. It is a more rapid growing tree than our native species and in many ways superior to them. It prefers moist, well-drained sites, and although not exacting with regard to soil, it grows best on reasonably fertile soils.

Norway spruce is tolerant of shade and grows well in pure stands or when planted in mixture with white pine, red pine or hardwoods. It is fast becoming an important tree for reforestation in this country, as it produces excellent pulpwood in from 30 to 40 years. It is also valuable as a substitute for white pine.

The young plants are susceptible to scorching by the sun when planted on south slopes where there is no protection. On sites of this type, fall planting is recommended, for if planted in the fall the trees can become well established before the hot weather of the following spring. It is the safest plan, however, to plant spruces where there is enough ground cover to protect them until they become established in the soil.

There are two objections to Norway spruce. One is that in the United States it seems to be short-lived, lasting only about 50 years, This does not decrease its value for pulp, as it produces an excellent crop in from 30 to 40 years, The other objection is that it does not reproduce well. Although it produces large quantities of seed, it is a rare occurrence to find seedlings in the neighborhood of old trees; hence stands must be formed artificially. For planting, 3 or 4-year transplants should be used.

HEMLOCK (*Tsuga canadensis*).

Hemlock is not common in Wisconsin, except in the northeastern part of the state. It is a slow growing tree and produces lumber of inferior quality, which until recent years was thought to be of little commercial importance. The bark is valuable in the manufacture of tanning extract.

Hemlock is very tolerant of shade, and grows in dense stands on moist uplands where the soil is of reasonably good quality. It is usually found mixed with hardwoods. Because of its slow growth and inferior quality, it is of little value for commercial planting.

BALSAM FIR (*Abies balsamea*).

In Wisconsin the balsam fir is a short-lived tree of small size and very inferior quality. It reaches its largest size in Maine, where it is of considerable importance. It does not thrive on sandy or acid soils, but prefers a moderately moist, deep loam.

Balsam is not recommended for planting in Wisconsin except for ornamental purposes. In large stands it dies, falls over and makes a very dangerous firetrap, the limbs often forming an almost impenetrable tangle.

WHITE CEDAR OR ARBOR VITAE (*Thuya occidentalis*).

White cedar is a common tree in Wisconsin. It is usually found in swamps and on moist sites where it forms dense stands. It is used for many purposes including posts, poles, ties and shingles.

The slow growth of the white cedar makes it a poor tree for commercial planting. It is a beautiful tree for ornamental planting and is particularly desirable for hedges as it can be trimmed to any form desired.

RED CEDAR OR JUNIPER (*Juniperus virginiana*).

Red cedar is widely distributed throughout the eastern half of the United States. It grows on the uplands, often in very dry situations although it reaches its best development on alluvial plains.

As it grows slowly, and is the alternate host for a rust that seriously affects nearby apple trees, it is a poor tree for either commercial or ornamental planting.

BUTTERNUT (*Juglans cinerea*).

Butternut is found in much of the Central Hardwood Forest region[*] including central and southern Wisconsin. It prefers good soil, moist but well-drained, and while quite hardy is most frequently found in protected locations.

The wood is used for furniture, boxes, woodenware, interior and exterior finish, and for many other purposes.

The butternut is a good tree for planting on good soil. It grows rapidly, and is desirable for shade trees and for timber. It is intolerant of shade and should be planted 8 or 10 feet apart each way. It may be raised from seed or purchased from nurseries, the latter method being recommended. 1 or 2-year seedlings are a convenient size for planting

BLACK WALNUT (*Juglans nigra*).

Black walnut is not of commercial importance in Wisconsin. While closely related to the butternut, it is less hardy and consequently does not have so great a range.

The walnut is very valuable and is used chiefly in the manufacture of furniture, in cabinetwork and for gun stocks.

Walnut prefers rich bottom lands, and grows best in protected locations. It is not recommended for extensive planting in Wisconsin, although it may prove successful in the southern part of the state. 1 or 2-year seedlings are the best size for planting.

BITTERNUT (*Carya minima*).

Bitternut is a native of central and southern Wisconsin, and has a wide range throughout the Central Hardwood Forest belt. It is a beautiful tree for ornamental planting but is of very little commercial importance in Wisconsin. It prefers a moderately good soil, and grows rather rapidly.

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[*] Map of Forest Regions of The United States; Bulletin 61, U. S. Department of Agriculture, Forest Service.

SHELLBARK HICKORY, SHAGBARK (*Carya ovata*).

Like the bitternut, the shellbark hickory is a native of central and southern Wisconsin. It prefers rich, moist sites. It grows slowly, and is not desirable for any but ornamental or shade tree planting.

The shellbark hickory has many uses, and is especially valuable for implement and vehicle stock. The nuts are of commercial value.

COTTONWOOD (*Populus deltoides*).

Cottonwood is widely distributed throughout the central and eastern United States. It is typical of moist sites, particularly along the borders of streams where the soil is of a fair quality.

Cottonwood is used for fuel, lumber and vehicle stock, and is now being used extensively for pulp. It is planted for shade, for windbreaks and for timber. It grows very rapidly, but does not clean well of branches, often sending out large branches 16 or 20 feet from the ground.

It is often grown from cuttings, although seedlings can be purchased from nurseries. It should not be planted near wells and sewers as the roots run toward water for long distances and frequently form large masses in them.

This species is known also as the Carolina poplar. It is not uncommon for it to make a growth of from 3 to 5 feet per year.

WHITE BIRCH (*Betula papyrifera*).

White birch is a very common tree in Wisconsin but is found principally in the northern half of the state. It is of little commercial value in Wisconsin because of its small size and the fact that it is seldom free from red-heart. The wood makes excellent fuel if split soon after cutting but if not split the close grained bark causes the wood to sour, greatly reducing its value for fuel.

White birch is a good tree for ornamental planting. The cutleaf variety sold by commercial nurseries is perhaps superior to our native birch for this purpose and can be purchased at a reasonable price.

YELLOW BIRCH (*Betula lutea*).

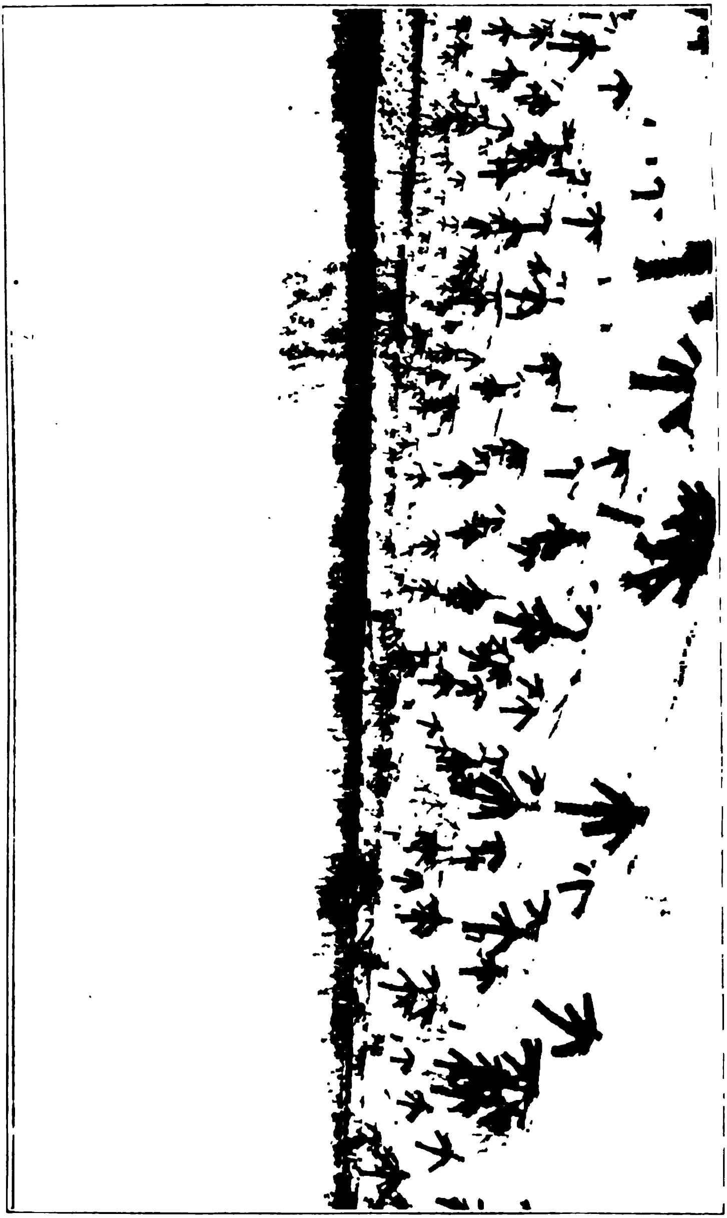
Commercially, yellow birch is far superior to white birch. Yellow birch grows on moist uplands where the soil is of good quality and it is usually found in mixture with other hardwoods and with hemlock.

The wood is heavy, hard and strong and adapted to a great variety of uses.

Yellow birch requires a low temperature, and is not recommended for planting. It has never been planted for commercial purposes in this country.

BEECH (*Fagus atropunicea*).

The beech has a wide range and is found on the better soils in the eastern part of Wisconsin. It is a beautiful forest tree and is easily



wn from seed. Because of its slow growth and the comparatively low ue of the wood, it should not be planted except for ornament. It is excellent tree for planting in parks.

RED OAK (*Quercus rubra*).

Red oak is found over most of the eastern half of the United States, uding all of Wisconsin. It is found principally on sandy soils and very common on ridges and hillsides. It is a hardy tree and grows idly. It also sprouts vigorously from the stump. It is used for many poses including ties, implements, furniture and veneer.

Many successful plantations of red oak have been made in the eastern tes. Plantations may be made with seedlings or by planting acorns, hough the former method is more certain of success.

Plantations need very little care. Seedlings may be planted from 6 10 feet apart, depending on the desired stand. 2-year seedlings are onvenient size for planting. Red oak is only moderately tolerant of de and therefore should be planted where it can receive plenty of sun- t. However, close spacing is desirable in order to get good form.

WHITE OAK (*Quercus alba*).

White oak is the most valuable of the American oaks. It is found on a iety of sites but prefers moist, sandy loam soils and warm situations. grows to large size, sometimes reaching a diameter of 8 feet but is com- ratively small in Wisconsin.

White oak has many uses. It is of especial importance in the manu- ture of tight cooperage and in furniture making and cabinetwork.

Unlike the red oak, the white oak grows very slowly but it is a per- ent grower and reaches a great age. Because of its slow growth it is ely used in extensive planting.

BUR OAK (*Quercus macrocarpa*).

Bur oak is closely related to white oak. It is more hardy than the ter species and is found on less favorable sites, although in many local- s the two are found in mixed stands. Both species grow slowly but white oak is usually the larger of the two when mature.

The wood of the two species is very similar and little or no distinction made in the market.

Bur oak thrives on a variety of soils but prefers soil of good quality. resists drouth well and is a good tree for prairie planting, where its nparatively slow growth is not so objectionable.

WHITE OR AMERICAN ELM (*Ulmus americana*).

White elm is distributed over practically all that portion of the United ates east of the Rockies. It prefers good soil and grows on both moist d dry sites. It does not grow in pure stands, but occurs sparingly mixture with other hardwoods. It reaches a height of 100 feet and liameter of from 3 to 6 feet.

The wood is very heavy, hard, strong and tough. It is used in manufacture of implements, wagon and buggy wheels, flour barr cheese boxes, cooperage, flooring and for many other purposes wher tough, strong wood is desired.

White elm is a good tree for planting on small areas or in mixture other hardwoods. It is one of the best species for street and park pla ing. It is also a hardy tree for prairie planting. It grows rapidly, often makes a straggling growth but this may be remedied by car pruning. For extensive planting 1 or 2-year seedlings may be used; for ornamental purposes, trees several feet in height are preferable.

SYCAMORE (*Platanus occidentalis*).

The sycamore is a common tree in the Central Hardwood Forest It grows on rich bottom lands and along the borders of streams. It is largest broadleaf tree in the United States, a specimen having rece been found near Worthington, Indiana, that is 150 feet in height a circumference of 42 feet and 3 inches.

The wood is heavy, hard and close-grained and is used for many poses, including the manufacture of tobacco boxes, yokes, butch blocks, furniture and interior finish.

The sycamore is planted largely as an ornamental tree, not for fo and grows rapidly on favorable sites. One serious objection to it is fact that it sheds its leaves early, usually during the month of Aug For street planting it is a desirable species, as it is little affected by sm dust and gases. It is also very free from insect attack. Trees of size up to 10 feet may be planted, and may be purchased at a reason price.

SILVER MAPLE (*Acer saccharinum*).

Silver maple has a wide range, including a large part of the ce United States. It prefers a loose, moist soil but thrives on a variet sites.

It is of little value as a timber tree and is planted chiefly where a r growing shade tree is desired. It is also a good shelter-belt tree. wood is used for fuel. The wood is brittle and is so liable to da by wind that it is a poor tree for planting on exposed sites. It is the best policy to plant it in mixture with other species.

SUGAR MAPLE (*Acer saccharum*).

The sugar maple is the most valuable of all the maples. It is a valuable tree for lumber and also for the sugar that is made from the

The range of the sugar maple includes practically all of the eas half of the United States. It reaches its best development on cool n erly slopes of hills, and in favorable situations is often very abun growing in dense stands.

Sugar maple is exacting in its soil requirements. It needs a moist soil of moderate fertility for good development. On dry sit on the poorer types of soil, its growth is very irregular and slow.

The wood is in almost universal demand and is used in 50 of the 55 wood-using industries of the United States. It is an excellent wood wherever a heavy, hard, strong and durable wood is desired.

On favorable situations the sugar maple grows rapidly and persistently. It is one of the most beautiful of all the trees, and is in great demand for street and park planting where smoke and gases, to which it is susceptible, are not likely to injure it. When grown in the open, it branches about 10 feet from the ground and forms a round, compact crown. In dense forest it has a long, clean bole and a small crown. It is very tolerant of shade, and succeeds best when planted where it receives some protection from the sunlight.

BASSWOOD (*Tilia americana*).

Although most common in the Great Lakes region, the basswood is found over most of the eastern United States. It attains its greatest size along the Ohio river, where it commonly reaches a height of 80 feet and a diameter of 2 feet.

The basswood prefers rich river bottom soils and cool situations, and should not be planted on poor soil or where it is likely to suffer from drought. It is rather tolerant of shade, and as the seedlings are easily injured by the hot sun, it should be planted where there is a certain amount of shade.

The wood is soft, straight-grained and easily worked. It is used for many purposes, including woodenware, carriage bodies, trunks, excelsior and paper pulp.

Basswood grows rapidly, and is an excellent tree for planting on good sites. It may be planted in pure stands, or in mixture with white pine or hardwoods. One year seedlings may be used, and may be spaced about 6 by 6 feet.

WHITE ASH (*Fraxinus americana*).

White ash is one of the most widely distributed and one of the most important hardwoods of North America. Its range is from New Brunswick west to Minnesota, south to eastern Texas, and east to the Atlantic coast. It prefers the rich, moist sites throughout its range and attains its largest size in the lower Ohio valley, where it commonly reaches a height of 80 feet and a diameter of from 2 to 3 feet.

The wood is very valuable and is in great demand where a wood of tough and elastic qualities is desired. It is of first rank for furniture, car, and vehicle construction, interior finish, agricultural implements and tools.

White ash is a good tree for both forest and ornamental planting. On good soils it grows rapidly, but on poor soils or in dry situations it grows rather slowly. When grown in the forest it develops a long clean bole, but in the open it branches 8 or 10 feet from the ground and develops a spreading crown. When young it is tolerant of shade, but the older trees require considerable light. It is an excellent tree for mixing with white pine and other species in forest plantations.

GREEN ASH (*Fraxinus lanceolata*).

Green ash is very similar to white ash in many respects. It has greater range, however, and is found over the greater part of the Unite States east of the Rockies. Like the white ash, it prefers low, moi ground, but unlike the related species, it is not exacting with regard soil and moisture. It grows well on dry sites and alkali soils but muc more slowly.

The wood is very similar to that of white ash and, although said be inferior in quality, there is rarely any discrimination between the tw species in the market.

Neither white nor green ash reproduce well from seed, and plantin stock should therefore be nursery grown. 1-year seedlings are from to 12 inches high, and are of a good age for forest planting.

Walter Mulford

THE FORESTRY COMMITTEE
OF THE
FIFTH NATIONAL CONSERVATION CONGRESS
PRESENTS THE REPORT ON

THE CONDITIONS UNDER WHICH COMMERCIAL PLANTING IS DESIRABLE

by the

SUB-COMMITTEE ON FOREST PLANTING

SYNOPSIS

THE conditions under which commercial forest planting is desirable is the topic considered by this sub-committee. The commercial basis for an investment in planted forest includes safety of investment, suitable regional conditions, a ready market, low initial cost of land and planting, and satisfactory returns at maturity. Fire, insects, and fungi need not be considered insurmountable obstacles to such an investment. If species suitable to climate and soil, which have good annual growth, and which meet market demands are chosen, favorable returns may be expected.

An investment in planting offers the least incentive to private owners since returns do not come within a short period, and money must be invested for 50 to 100 years. An exception is the planting of quick-growing species or of slow-growing trees for utilization when small, as for post production, where regional or market conditions are favorable. Here returns come earlier and are proportionately higher. Long-lived corporations and communities have a much greater incentive to plant forests than individuals. Most of all, a long-time investment like planting is feasible for the States and the Federal Government.

The report shows the great necessity for an adequate plan of commercial planting by States and the Federal Government. More than $65,000,000 worth of wood is lost annually while the available lands remain deforested. The Federal Government, in co-operation with the States, can wisely expend millions in order to dull the edge of timber famine when it comes.

The following summary ends the main report of the Committee, which is further supplemented by an appendix containing a condensed discussion of forest planting in each of the natural forest regions.

(1) Although interest in forest planting is increasing, the actual area planted each year is very small in contrast to the millions of acres which require reforestation.

(2) An investment in planting should be made relatively safe from loss, especially by fire. Organized fire prevention and control have minimized losses from this source. Adequate fire protection is sure to come if extensive planting is undertaken.

(3) Successful commercial planting depends upon a good future market, lands of low value on which to plant, a choice of species suited to the needs of the market and to the conditions, local and regional, relative freedom from sources of damage, a low initial cost of planting, and a return on the money invested equal at least to a fair rate of interest. Many examples of successful plantations exist which meet these conditions.

(4) As an investment forest planting is not attractive to the small private landowner excepting where other valuable considerations exist, such as appreciation of land values or early returns from quick-growing species. The long-time nature of the investment makes planting more feasible for federal, State and local governments or long-lived corporations than for the individual or small company.

(5) The problem of reforestation of denuded lands should be met squarely by entering upon a comprehensive plan covering at least a fifty-year period. Such a plan should include adequate federal and State appropriations, an extension of State forests to include more waste lands, federal aid for States, State aid for counties, cities and towns, and encouragement of private planting.

(6) Sixty-five million dollars, at least, are being lost annually because denuded forest lands remain unproductive. Reforestation will go far toward lessening the severity of the coming timber famine, provided it is done on a large scale and begun at once.

INTRODUCTORY

THE topic selected for discussion by the sub-committee on planting is the conditions under which commercial forest planting is desirable. Interest in this work has been increasing during recent years. The total acreage annually planted, however, is utterly inadequate to bring into productiveness within a reasonable period the very great area which requires reforestation. It will require Federal, State, private and corporate planting on a large scale, annually, to reforest denuded lands so that the United States may receive the benefit of additional timber supply when the period of great scarcity of timber begins.

It is chiefly the purpose of the report to point out the fundamental facts concerning commercial planting, its drawbacks and its advantages. A discussion of commercial planting in the various forest regions is appended to this report as a compilation of available data and a basis for consideration of its recommendations.

COMMERCIAL BASIS FOR FOREST PLANTING

Safety of Investment

IT is essential that a commercial enterprise be relatively safe from loss or destruction. Danger from forest fires has been regarded in years past as sufficient to render an investment in planting wholly impracticable. In general, this danger has been greatly exaggerated; yet it does exist as a local problem and must be taken into account in determining protective measures for each prospective planting. Fire in a young planted forest of conifers usually kills the trees; in hardwoods it may kill or seriously injure them. Organized work in fire fighting and more effective prevention of fires in many of the forested States has minimized losses from this cause. Thus, in the record of Connecticut* planting, less than one per cent of the total planted area was destroyed by fire in 12 years. In this thickly settled region the causes of fires are numerous and the number of fires large. Protection of planted as well as natural forest lies, primarily, in the hands of the State and Federal Government, and must be assured to the people in each State where the danger exists. Adequate fire protection is sure to come if extensive planting is done.

Measures of prevention rest not alone, however, with the State, but must be supplemented by the efforts of individuals and of corporations who undertake planting. Local protection by fire lines and by other means has proven adequate to protect planted forest adjoining railroads and which was open to danger from other causes of fires. A decade of educational work and organized fire prevention has removed, to a large degree, this objection or stumbling block to the planting of forests.

The danger of losses due to insects, fungi and other injurious agencies does not necessarily render an investment in planting unsafe. Careful judgment in the selection of species and mixtures, as well as subsequent economic measures for preventing losses or reducing the damage, are reasonable safeguards in this espect.

So far as taxation is concerned, there is steady progress in legislation to do way with injustice arising from repeated taxation of the forest crop. Taxation f the land alone annually at a low valuation and a tax on the crop when cut eems to be the plan most favored. It is reasonable to expect that future planted orests will not be unreasonably burdened with taxes. Laws granting exemption rom taxation on planted lands for longer or shorter periods have entirely failed o stimulate reforestation.

REGIONAL CONDITIONS.

If planting is to have a sound commercial basis, both regional and local onditions require careful consideration. A study of regional factors may etermine at the outset the advisability or inadvisability of planting.

Climatic factors, temperature and rainfall, determine broadly the possible pecies in natural forest regions from which selection may be made for reforestaion. A consideration of temperature may be sufficient to eliminate consideration f a given species, as, for example, eucalyptus in regions whose minimum emperature falls below 25° to 30° Fahr., or, catalpa, which is often recomended for commercial planting, in regions where it is subject to frost injury. n the extension of a species to the extreme limit of its possible planting range he shorter growing season may so reduce its average yield or conditions may o affect its form as to make it unprofitable for planting.

Topography and soil are the important factors which determine forest types, hence, in forest regions these factors must be considered in deciding the practicability of forest planting and in the preparation of plans for commercial reforestation of waste or denuded lands. A safe basis for decision is assured if areas are mapped and the physical types of land located with reasonable accuracy. Full notes of local conditions are needed upon which the determination of suitable species may rest. Important details of site are included under slope, aspect or exposure, altitude, soil in respect to kind, depth and moisture, underlying rock, etc. Other facts are essential in planning large operations, but the considerations named are fundamental in reaching decision as to species on lands formerly well forested and where the presumption is reasonable that they may again be made productive. If similar sites in forest may be studied within the locality, facts will be secured to substantiate the observations of the physical nature of the deforested lands. If species are planted which are poorly suited to locality, the chance of a valuable crop at the end is gone at the outset. Briefly then, an intimate knowledge of regional and local conditions is absolutely necessary as fundamentally affecting the commercial success of reforestation.

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* Rept. Conn. Agri. Exp. Station, 1912.

In regions not naturally forested as in the prairie and plains country, data concerning climate and physical factors of locality are even more essential coupled with a knowledge of the silvical characteristics of forest tree species.

An accessible market within the region and a reasonable certainty of a steady future demand is necessary to any form of forest management. The species chosen for planting must meet market requirements in addition to being suitable for the sites on which it is to be set. Its rate of growth and relative freedom from insect damage must be known.

INITIAL COST.

In commercial forest planting a small initial cost is demanded if full profi is to be taken at the maturity of the crop. Since the investment covers a long period, it is desirable that the cost per acre of forested land be as low as possible without menacing the successful establishment of the forest.

Initial cost comprises value of land, cost of trees and all expenses attendan to setting them. Natural forest land without timber is available at low prices An arbitrary upper limit might be set at $25.00 per acre, and this too high save under exceptional conditions. Most of the land held or acquired for fores planting in the Eastern United States has been much less than this, ranging generally well under $10.00 per acre. The cost of trees has been brought within reasonable limits by development of State nurseries and by the establishment of private nursery companies.

Cost of setting trees varies greatly, depending upon local conditions of site and availability and quality of labor. It is not difficult to plant successfully at a low figure and this has been done by many classes of owners under varying conditions. A general figure of cost in Eastern forest planting is a cent a tree set. It has often been lower than this, occasionally higher. With a 6′ x 6 spacing this would amount to approximately $12.00 per acre. An average figure of $11.86 per acre was secured in compiling data of the total cost per acre of private forest planting in Connecticut. Planting on a large scale by the New York Conservation Commission in the Adirondacks has been done at a much lower figure.

Excepting on lowlands affording favorable conditions, plains and prairie planting with its additional two years cultivation to ensure initial success costs from $15.00 to $25.00 per acre. Eucalyptus planting costs in California may be set at $25.00 per acre, including preparation of site. Federal forest planting in the National Forests has varied widely in cost according to the conditions under which it has had to be done. Its purpose is more than commercial production, since much of the work includes water conservation by forest planting. In large operations on accessible sites presenting no unusual difficulties, the cost per acre is about the same as in planting expenses in Eastern forest regions.

RETURNS.

A high rate of return cannot be expected from an investment in forest planting. It is generally reckoned at 4% to 6% on the investment, with a small net profit per acre. Further than this, in the great majority of cases the return does not come within a short period of years. Eucalyptus within its limited planting range will be merchantable in one to two decades and yield higher returns than those given above. Fence post species yield their crop within 15 to 25 years at a considerable profit. The shortest period for timber production is, in general, 35 to 40 years, and for large timber 60 to 100 years. Such long deferred returns as the latter are not attractive in themselves to the investor, but there must be and there are in many instances other considerations in commercial forest planting. By itself as a business venture, forest planting does not hold the position which short time business investments do. It does not generally appeal to the private landowner from this standpoint. Such an investment does, however, assume an important position when it directly affects capital already invested or properties that are to be held perpetually for timber production.

COMMERCIAL FEASIBILITY OF FOREST PLANTING AS DETERMINED BY OWNERSHIP AND OTHER CONSIDERATIONS

PRIVATE INDIVIDUALS.

PLANTING of quick growing species suitable for domestic purposes and for sale is feasible wherever the return is not less than from other possible uses of the land. This applies particularly to the resident owner who will thus secure his own supply, fence posts for example, and can sell the balance to advantage. In view of this he may even be willing to accept a lower return from the soil than it might otherwise bring. In many instances, however, inferior land will be used for this purpose. In wind-swept regions the protective influence of a shelter belt brings higher money return in increased crops on land adjoining the forest.

The short period for growth encourages such planting and other useful results add to its desirability. Commercial planting of this kind is much to be desired in farming regions that are treeless, or in woodlot regions where wood is scarce through continued cutting, and the prices of needful farm materials have become high.

Although reforestation for timber production is not often attractive to the private owner, many small plantations are being set yearly, especially in the eastern United States. Planting by individuals is often a matter of personal interest in such work for the purpose of improving property so that no part of the land is idle, and with no idea on the owner's part that he himself will harvest the timber. He simply sees his property improved and enhanced in value, more easily sold or left in better condition for his children.

As an investment timber planting by private owners must be considered in connection with the steady appreciation in value of forest products and in the price of land. There are many localities in the Eastern United States where waste lands are remarkably cheap. These are non-agricultural, but with the increase of values for other types of land in the locality the price of these lands is rising. Good roads and transportation by automobile have put extensive areas within reach of larger and smaller cities for country residence. This line of development will continue. Planting on such lands will add distinctively to future sale values.

The purchase of land by non-resident owners and setting it with forest trees is relatively infrequent. Such planting must be viewed purely from an investment standpoint and offers little to the private individual as compared to other business ventures.

Private Corporations: Corporations, lumber companies and wood working industries which depend upon buying stumpage for their supply and own practically no woodland have no incentive for forest planting. When supplies are exhausted locally the plant is removed to new territory or abandoned. Many of these small corporations are comparatively short lived, and do not wish to invest further capital which cannot be released except after many years. Such companies also may not have capital available for such purposes.

There are other corporations and small companies that own some timberland and also buy stumpage to supply their industries. Such corporations have held their own timber for the time being uncut, as a reserve to prolong the supply, cutting only the purchased stumpage. From this stage the idea has developed of buying young woodland and lands where natural growth of the desired species has become well established. A further practical extension in application of this idea in one case has been the purchase of cheap lands suitable for growth of the species needed and the reforesting of them artificially. Such a plan worked out fully where circumstances permit means a continuous supply for the local industry concerned, provided reproduction is secured either naturally or artificially.

Another class of corporations are those holding a large acreage of forest land. They are permanent in character and the problem before them is how to make certain an annual cut to supply their mills perpetually. The paper and pulp companies in the spruce region of the Northeast exemplify this class. Their problem is one of forest organization. In such cases the viewpoint of forestry is presented, namely, continuous crops of timber from the same land. Natural regeneration will most probably be given first consideration by the employment of silvicultural methods. Forest planting will supplement natural reproduction, and may also be applied to waste, cut-over lands and burned areas to bring them into productiveness. Forest planting becomes simply a rational part of forest management by the corporation. There is every incentive for such corporations to utilize planting where it is practicable and such expenditures are an increase of capital to develop property. Capital is usually available and the long time nature of the investment is not an obstacle.

Public Utility Corporations: The future annual supply of railroad materials, especially cross-ties, is essentially important to every railroad corporation. It is estimated that 15 to 20 per cent of our annual timber consumption is railroad materials. The working out of the problems of a future supply may or may not have any connection with forest planting. The location of the railroads in reference to forest regions, together with the climatic and physiographic characteristics of these regions, the present land holdings of the company, the advisability of using treated ties, etc., are some of the factors entering into the problem. It is no solution of the problem merely to say that if railroads need ties, let them plant trees which will furnish them; a statement once made in this respect. For one thing, trees planted now for ties will not mature soon enough to meet the shortage of cross-ties which is surely coming. A hundred million planted trees under 6 inches in diameter would not help a railroad in the cross-tie crisis of fifteen or twenty years hence; yet this is no reason why they should not be planted to furnish ties forty years from now.

So far as the region is concerned, if a railroad traverses a treeless prairie and plains region, such as the Middle West, a policy of planting trees for tie production in that region is not fundamentally sound, and experiments already tried do not seem to warrant further attempts. A treeless, windswept prairie country does not offer, silviculturally, advantageous sites for successful tie production because of limitation as to species and their growth, as well as other factors. One such railroad which extends to the Pacific coast is experimenting in the planting of eucalypts in Southern California for tie production. This is a possible exception to the general principle just stated, but in this case eucalyptus planting within its limited planting range offers at least a reasonably sound basis for such an experiment, although present indications are that the work will not be extended.

The source of tie supplies and other railroad material must, then, be our natural forest regions. If a policy of timber land acquirement by a railroad is found to be practicable, or if a railroad owns forest land, planting of forest takes its usual place in the organization and management of the railroad company's forest.

Lands which have been cut over and burned so badly as to require restocking to secure valuable growth should be planted, and all open lands within the company's holdings made productive in this way. The object of such planting is profit, the highest return per acre possible. Species which will yield material suitable for treated or untreated ties may be selected if adapted to the region and to the sites, but such need not be the ruling factor in making the choice. The object rather is to plant what will bring the best returns, not disregarding, however, the maintaining or improving of the fertility of the site. Railroads with medium to high earning capacity can afford to increase capital account to make their lands yield a return instead of paying taxes annually and letting them lie unproductive. As in the case of any other long-lived corporation an investment covering a long time is not an obstacle to the company.

With coal companies the problem of future supplies of mine props and other material is chiefly connected with the length of time the coal owned or controlled by a given company will last. Extensive planting may be desirable, or it may be determined that the regional supply of timber will be sufficient or can be supplemented by planting. Planting of surface owned by the company is the simplest use to which it can be put. If such planting occupies land in a bituminous coal region where open coking ovens are used, its general success may be lessened materially or prevented by the effect of sulphurous gases.

The feasibility of planting by water companies is apparent by a brief survey of conditions and opportunities. Large areas have to be owned to protect the purity of supply. Such lands offer the best protection if forested. Even though the water may be filtered before use, benefit is derived from forested watersheds. Lands acquired on watersheds usually include many open farm lands which should be planted. Much of this work has already been successfully done by New England water companies and each year additional acreage is being set with trees. It is the most satisfactory crop for the lands considering their purpose and an excellent future profit is assured owing to nearness of market in nearly every instance.

Community Forests: What has been said in reference to private companies furnishing water supply for cities and towns applies to the feasibility of forest planting for cities and towns which own and manage their own water systems. Areas owned are sufficiently large to yield ultimately a high money return to the community. Once established, such forests will furnish regular crops of timber which can be used for city purposes or sold. In either case taxes will be reduced or the water rate can be lowered to a minimum figure. Some States* have recently passed laws permitting counties, cities, towns and villages to acquire forested lands or areas suitable for tree growth for the establishment of community forests. Such forests have many uses, among which are water protection, timber supply, park forests, etc. Their future value will be very great and they will provide useful material at a future time of local and regional scarcity of timber.

Some communities are in a position financially to carry these laws into effect and need only to be shown the possibilities and opportunity. The majority, however, cannot undertake an extensive program of forest planting without State aid. The city of Seattle has recently planned a very extensive planting operation in its large watershed. This is independent of State aid and while involving heavy expenditure promises very definite and high returns.

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* New York and Pennsylvania.

State Forest Planting: Is it advisable for States to enter upon an extensive plan of commercial forest planting? The policy of State ownership and management of forest lands is now recognized by many of the States. In New York and in Pennsylvania a million to a million and a half acres have been acquired under such a policy. Development of forest management under this policy implies forest planting to restock denuded and burned areas within the State forests and to protect sources of stream flow. Massachusetts* has a policy of purchasing private waste lands and has provided a small appropriation annually for their reforestation by the State. Such lands, however, can be repurchased by the owner subsequently. Nine hundred to one thousand acres are being planted annually under this policy. No States at present are planting over one thousand acres each per year and few attain that figure.

The State can well afford to go much farther and enter into a plan of commercial forest planting for the sake of future industry and supplies for its citizens. The State does not enter into competition with private investors since timber production by forest planting is not sufficiently attractive to induce extensive private planting.

The State has the power to secure and appropriate funds for such work, which is comparable with other public work, such as road building, swamp drainage and irrigation. Non-agricultural forest lands now denuded must be made productive to meet future demands. This is just as important as making farm lands of higher productive value through the building of good roads, or an increasing of farm areas by drainage or irrigation, initiated and financed by the State. The more extensive the area requiring forest planting, within the States, the more advisable is the immediate commencemnt of such work.

Federal Reforestation: The Federal Government has nearly 190 million acres in the National Forests which are under management for the purpose of protecting stream flow and producing continuous crops of timber. Protection of these forests from fire and the proper cutting of mature timber so as to provide for another crop of valuable trees on sale areas are given a place of first importance in the federal policy. Next to this is placed the task of starting forest growth on a vast area of denuded lands.† It is estimated that 7½ million acres of such land in National Forests require reforestation. The government policy places planting for watershed protection first and commercial planting on lands which produce heavy stands of quick growing species, second. Under present plans, 30,000 acres are to be reforested annually. Planting is more difficult on the whole than in the Eastern United States and continued experimentation is required. Climatic factors and physical conditions of planting sites offer complex problems. Planting for commercial profit will be impossible in many portions of the National Forests. Gain will come to the nation through protection of stream flow and in the re-establishment of forest growth on denuded lands to augment future local supplies of timber. The Federal Government can carry out this work in National Forests to better advantage than individual States could. There should be no lowering of the present standard of annual planting or the amount of funds available for this purpose each year. Increase in the National Forest planting budget should be made as fast as experimental work indicates satisfactory methods.

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*Reports of the Massachusetts State Forester, 1908-1912.

†"Reforestation on National Forests," by W. T. Cox. Bull. 98, Forest Service, U. S. Department of Agriculture, 1911.

NEED OF FEDERAL AND STATE AID IN REFORESTATION ENTERPRISES

The Opportunity

THE National Conservation Commission in 1909 conservatively estimated denuded lands in the United States in need of planting to be 65 million acres, including that in natural forest regions and in treeless regions. Unless reforestation on a large scale is entered upon, there will be but little diminution in this area of denuded land in a hundred years. Each year's delay in making the investment means a money loss represented by the growth planted forest could be making on this immense area. At an estimated return of only $1.00 per acre per year, this annual wood growth amounts to a yearly loss of 65 million dollars to the nation. Within fifty years our virgin timber will be gone and much of our second growth. To meet future needs of timber denuded lands must be brought into productiveness. Reforestation on a large scale is absolutely essential to the Nation's welfare. Both Federal and State action is necessary to place reforestation on an adequate scale. Federal aid should apply to States within natural forest regions having denuded and waste lands. Planting within prairie and plains regions serves almost wholly to benefit the individual owner through furnishing domestic supply of farm materials and by protection to the owner's crops.

The Federal Government has adopted a definite policy in forest conservation by creation, administration and management of the National Forests created from public lands and more recently acquired in the East by purchase under the Weeks Law. It has further provided for protection of stream flow, and thereby incidentally for future timber supplies by financial aid to the States in protecting forests on important watersheds from destruction by fire.

The acquisition of waste lands by the Federal Government for National Forests should be greatly extended and the present restriction limiting the acquisition of such lands to the watersheds of navigable streams removed, on the broad basis of the public need for greatly increased wood production for the future, regardless of State lines.

The acquisition of similar lands by States should also be greatly extended.

Federal aid should be extended to the States requiring it on the same plan as it is for fire protection under the Weeks Law, namely, that the State appropriate an equal sum for forest planting under a co-operative agreement with the Government. Expenditures should be restricted to the planting of non-agricultural lands which have been classified by competent authorities.

A 50-YEAR PLAN FOR NATION AND STATES

A definite policy should be adopted both by the Federal Government and the States for the next 50 years for reforestation on a large scale under as many as possible of the plans outlined. Appropriations for this purpose may be regarded truly as a valuable investment by the nation and the States, both of which, because of their credit and the low interest rates obtainable, are able to enter upon a long-time investment which cannot be undertaken by private capital on any extensive scale.

The following schedule of appropriations by the Federal Government and by co-operating States is suggested, the amounts being made relatively small at the outset to ensure a normal development and effective continuance of the planting policy.

DECADES	Federal Appropriation	Total amount granted by federal government	Total amounts contributed by co-operating states
	Dollars (Annual)	Dollars (Per decade)	Dollars (Per decade)
1914-1923	500,000	5,000,000	5,000,000
1924-1933	1,000,000	10,000,000	10,000,000
1934-1943	2,000,000	20,000,000	20,000,000
1944-1953	3,000,000	30,000,000	30,000,000
1954-1963	4,000,000	40,000,000	40,000,000
		105,000,000	105,000,000
Grand total in years			$210,000,000

Such a co-operative undertaking successfully carried out would ensure the planting of over 20,000,000 acres, or over 50 per cent of our natural forest lands now denuded and incapable of being regenerated naturally. The cost for 50 years is less than that for maintaining our military and naval organizations for one year. Such extensive planting would encourage planting by long-lived corporations and by private owners. Counties, towns and municipalities can be assisted by the State. This would undoubtedly add several million additional acres to those planted by the Federal and State governments.

Planted forests of the next two decades would yield returns by the end of the 50-year reforestation period. Eventually, under a rational forest management, this 20,000,000 acres would yield 6,000,000,000 board feet per year, estimating the annual yield per acre at only 300 board feet, a conservative figure. Such returns would be of inestimable value to the whole nation during the last half of this century when scarcity of wood will be most keenly felt.

What the States Can Do.

The policy of acquiring forest lands by the State, or denuded areas of non-agricultural lands suitable for forest growth, is well established in many of our States. An extension of that policy to other States in natural forest regions and within States where it now exists is much to be desired. Such an extension requires a more thorough classification of land and a more advanced forest policy. States should ensure future supplies of timber by owning and managing arge areas and by reclaiming waste and denuded lands on a large scale. Federal aid, whether by direct appropriation divided among co-operating States as ndicated above or in the form of a Federal loan, should be applied to extensive planting on State lands. Federal and State work must be further supplemented by county, town and municipal planting. There are several methods that suggest themselves for State aid of community planting.

> (1) Legal permission by the State to local governments (county, city, town, village) to bond themselves or raise money by loan for the purpose of acquiring and planting denuded lands. (A measure already in law in New York State.[*])
>
> (2) Same provision as (1) in reference to bonds or loans, but State to furnish plant material free of charge to counties, cities, towns and villages.
>
> (3) State loans with interest at 3% for a 50-year period to county or local community for use in acquiring land and planting it; to be secured by a lien on the first timber returns. ([†]This plan was suggested by Dr. B. E. Fernow in an address delivered at the annual meeting of the Society for the Protection of New Hampshire Forests, Lake Sunapee, N. H., July 23, 1913.)
>
> (4) County, town, city or village having or acquiring land for reforestation to give deed to the State which reforests the land and manages it. Within a given period the land may be redeemed upon payment by community of reforestation costs with interest at 3%, provided the forest is thereafter managed in accordance with a working plan prepared by the State Forester and under his supervision.

The States should continue present encouragement of private planting by furnishing advice and planting stock at cost where such is not available from private nurseries at reasonable prices. It is very doubtful if financial aid to private individuals, associations, companies or corporations either in the form of free plant material or money subvention is advisable. The State's own reforestation work and State aid, as indicated above, on a large scale would prevent any assistance of this sort.

SUMMARY AND CONCLUSIONS

(1) Although interest in forest planting is increasing, the actual area planted each year is very small in contrast to the millions of acres which require reforestation.

(2) An investment in planting should be made relatively safe from loss,

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[*] Chapter 74, Laws of New York, 1912.

[†] "A Plan to Meet Our Needs for Wood Timber," American Forestry, Vol. 19, No. 8, page 521.

especially by fire. Organized fire prevention and control has minimized losses from this source. Adequate fire protection is sure to come if extensive planting is undertaken.

(3) Successful commercial planting depends upon a good future market, lands of low value on which to plant, a choice of species suited to the needs of the market and to the conditions, local and regional, relative freedom from sources of damage, a low initial cost of planting and a return on the money invested equal at least to a fair rate of interest. Many examples of successful plantations exist which meet these conditions.

(4) As an investment forest planting is not attractive to the small private landowner excepting where other valuable considerations exist, such as appreciation of land values, the protection of crops by wind breaks, or early returns from quick-growing species. The long-time nature of the investment makes planting more feasible for Federal, State and local governments or long-lived corporations, than for the individual or small company.

(5) The problem of reforestation of denuded lands should be met squarely by entering upon a comprehensive plan covering at least a 50-year period. Such a plan should include adequate Federal and State appropriations, an extension of Federal and State forests to include more waste lands, Federal aid for States, State aid for counties, cities and towns and encouragement of private planting.

(6) Sixty-five million dollars at least are being lost annually because denuded forest lands remain unproductive. Reforestation will go far toward lessening the severity of the coming timber famine, provided it is done on a large scale and begun at once.

APPENDIX

FOREST PLANTING BY REGIONS*

NORTHERN FOREST

THIS region includes the greater part of New England, New York, Pennsylvania and the Lake States, extending also in a narrow strip along the Southern Appalachian Mountains to Georgia. The greatest area of denuded lands in the United States requiring reforesting lies within this region. Private and corporate ownership exceeds government holdings. New York, Pennsylvania and the Lake States each have a considerable area of State forests which include much land that is at present unproductive. The Federal Government is acquiring land under the Weeks' Law for national forests in the White Mountains and in the Southern Appalachians and has national forests in the Lake States. All of these federal holdings, however, amount as yet to a relatively small area when compared to that of the whole region.

North Woods.

The broad divisions of the forest in the Northeastern United States are the spruce region, northern hardwoods and the white pine region.

The Spruce Region is one of natural forest soils, not suited to agriculture. Its topography is rugged. Red spruce is the predominant conifer, growing in nearly pure stands or in mixture with hardwoods and with other conifers. Hard maple, beech, and yellow birch are the principal broad-leaved deciduous trees. Spruce forest covers the larger part of northern New England, the Adirondack section of New York State, and this species is to be found on the highest elevations in the Southern Appalachian Mountains. The forests occur in almost continuous areas, and the region is little settled. The extent of individual holdings is on the average large, and some paper and pulp companies have very extensive holdings.

Generally speaking, natural reproduction in spruce forest is good under average conditions. Fire has destroyed the valuable species on large areas, and clean cutting in a portion of the region has denuded mountain slopes, for example, in the White Mountains of New Hampshire. Natural seeding of poplar and birch has produced valuable forests of these species on burns in this region, but repeated fires have created waste areas. Forest planting in the spruce region is not at present considered practicable as a general method of reproducing forests, since natural reproduction is abundant. For the most part, therefore, natural seeding will be depended upon to secure a new crop.† Planting is, however, advised in the old field spruce type, one of the subordinate types, as the best means of reproduction.

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* Classification in general according to map "Natural Forest Regions of North America," Forest Service, U. S. Department of Agriculture, 1910.

† "Forestry in New England," by Hawes and Hawley, 1912.

Forest planting finds its principal use within this region for stocking burned lands that are not reproducing with valuable species. Since native spruce is not rapid in growth, the introduced Norway spruce is recommended. Its use in the United States has been chiefly for ornamental planting, but there have been instances in which it has been planted for commercial purposes. Its rate of growth is shown to be very rapid in a small planting, 34 years old, on the Billings' estate in Vermont. This plantation is estimated to have grown an average of a cord and a half per year. Tests of trees from this plantation have proved that the wood makes a good quality of paper. It is not a difficult tree to propagate in the nursery. The average cost of raising the trees and making a plantation with four-year-old transplants of Norway spruce, spaced 6 x 6 feet apart, is approximately $10 per acre.* An objection to the Norway spruce has been pointed out, namely, that it seems to deteriorate after 50 years. Owing to its rapid growth, this does not hinder its use in commercial planting for the production of pulp wood, but may affect its value as a large timber producer.

The Northern Hardwoods Region adjoins the spruce region, and is hilly rather than mountainous. The principal species are those mentioned above, including also a small percentage of white ash, basswood and red oak. The soils are of good quality, and the region is generally more settled. The forest is not continuous, but woodland forms a part of nearly every farm, ranging in area from a few acres to several hundred. Woodlots have a larger average area in northern New England than in the southern part. Planting at present is applicable to open farm lands not needed for agricultural purposes. It will also be useful in the conversion of inferior hardwood forests into a more valuable coniferous type.† The region contains no extensive areas of sandy waste lands. The purpose of planting is chiefly the production of commercial timber, and should largely be carried out by farm owners in the region, individually, or by communities, Species of value for planting are white pine, red pine, European larch, Norway spruce, white ash and basswood.

‡ *The White Pine Region* of the Northeast has been so named from one of its chief species of trees. White pine is to be found in the spruce region and associated with trees of the northern hardwood region. It is not, however, a prominent part of these forests. To the south and southeast of these regions in New England this species is typical of the forest, occurring in nearly pure stands on inferior soils and associated with hardwoods on better soils. In New York it was associated with hardwoods and still occurs in mixture. Its principal associate in Pennsylvania forests was hemlock, and it formed a greater or less percentage of the hardwood forests in that State.

In the New England region, second growth stands have been very numerous on abandoned fields. Second-growth lots have usually been cut clear when merchantable, and large areas have, as a result, been occupied by inferior species or by brush. Fires have added to this area. The region is well populated and the land owned, for the most part, in small lots by private individuals. State-owned land amounts to a small total area. Second-growth white pine occupies a less prominent place in Pennsylvania forests than original growth. It has given place to hardwoods on many sites. Fires which followed cuttings in Pennsylvania have been chiefly responsible for the formation of extensive waste areas requiring reforestation. Pennsylvania* has acquired nearly a million acres of State forest land and has reforested approximately 4,000 acres thus far.

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* "How to Grow and Plant Conifers in the Northeastern States," by C. R. Pettis, Bull. 76, U. S. Department of Agriculture.

† "Forestry in New England," by Hawes and Hawley, 1912.

‡ Ibid., 1912.

Species most important for reforestation in the white pine region of the Northeast are white pine and red pine. Scotch pine may prove useful for the poorest lands. Hardwoods, such as white ash and red oak, deserve use on sites to which they are suited.

Several million acres require reforestation in the whole region. Unprofitable farm land, poor pastures, brush land and sandy wastes comprise some of the chief types of land for forest planting. The estimate of the National Conservation Commission in 1909 for New England alone was 2,500,000 acres requiring planting, a conservative figure, to which must be added a large area for New York and Pennsylvania. In the management of forest lands it will, in many instances, be practical to cut inferior woodland clean and reforest with pine.

Initial cost of planting generally ranges from $8 to $12 per acre, usually approaching the latter figure if three-year transplants, which are to be preferred, are used. The cost of labor usually ranges from $1.50 to $1.75 per day. Trees are commonly spaced 6′ x 6′ apart. Older plantations indicate a profitable yield. The following table gives the yield of several of these:

No.	Location	Species	Age	No. Trees Per A	Total Yield per Acre Bd. Ft.	Mean Annual Growth Bd. Ft.	Quality of Site
1.	Connecticut	White pine and Eur. larch	22	1312	12,280	558	Medium
2.	New York	White pine	28	1200	23,000	857	Good
3.†	Connecticut	White pine	31	1200	15,052	486	Poor
4.‡	Connecticut	White pine	50	276	41,720	834	Medium
5.	Connecticut	White pine	75	524	60,360	862	Poor

Estimating the stumpage value of Nos. 1 and 3 at $5 per M bd. ft. and Nos. 4 and 5, in which the timber is larger, at $7 per M bd. ft., the following table shows the financial value of the standing trees per acre:

No.	*Value of stumpage per acre.*
1	$61.40
2	115.00
3	75.26
4	292.04
5	422.52

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* Report of the Forest Commission of Pennsylvania, 1912.

† Dense stand by seeding—too dense for normal development.

‡ Natural stand, not planted; here introduced to indicate yield at that age.

Although conditions are especially favorable for private commercial planting in the Northeastern United States, its progress if judged by area is relatively slow. Probably more interest exists in forest planting within this region than in any other of the natural forest regions of the United States.

LAKE STATES

THIS part of the northern forest region is level to hilly in topography and occupies the greater part of Michigan, Wisconsin and Minnesota. Broadly the forest types are swamp, pine and hardwood, respectively. *The swamp type* varies in composition and character, but includes among its principal species spruce, cedar and tamarack. The composition of such swamp types may be one of these only, as tamarack swamps, or it may be spruce and tamarack, or cedar. Within this type, which occupies moist and wet lands, there is no field for commercial forest planting. Growth is very slow.

The pine type occupies sandy loams and sand soils. The principal species in the pineries are white pine and red (Norway) pine. On the poorer soils the red pine and Jack pine are the chief trees. Most extensive areas in need of reforestation are to be found in this type. The rate of growth is medium. In Michigan, on the higher, more northern lands and on pure sands, it is slower.

The hardwood type occupies good soils, generally agricultural in character, excepting rocky hills. Pine originally formed a small per cent of the forest, and is still found in mixture. Hemlock also occurred in this type in portions of the Lake States. The chief hardwoods are yellow birch, beech, sugar maple, white ash and basswood. Forest planting on this type occupies a minor position and will probably always be of less importance than the planting of pine lands. Its place will be somewhat similar to that which it has in the northern hardwood region of the Northeastern United States. The same species will be useful for reforestation.

Ownership of land is generally private, reforestation lands in the Lake States being held in areas of considerable size by lumber companies, by development companies and by individuals. An active State forest policy is in effect in Wisconsin and Minnesota by which non-agricultural cut-over lands are being acquired for eventual reforestation. There is also commendable State activity in Michigan. The Federal Forest Service has begun planting on national forests in both Minnesota and Michigan. The States are at present just entering upon this work. The total planted area, federal, State and private, is known to be small, although no census of it has been taken.

Forest planting in the Lake States is commercially feasible, judging by the increasing market for pine and hardwoods and by the available statistics of natural growth. Species for planting in the pine type are white, red, Scotch and Jack pine. The last mentioned is useful on the poorest sands, and a stand may be secured by spreading cones on newly burned lands, a method both cheap and effective for this species. Good transplants of white pine and red pine must be used in the reforestation of pine lands with these species. Professor Roth, of the University of Michigan, recommends good, sturdy stock and wide spacing, 10 feet or more, since clearing up the lands is too costly and this money can to much better advantage be used in protection from fire during the two months of greatest danger. Planting can be done at as low a figure as $6 per acre, and will pay. He estimates the area within Michigan requiring reforestation at 10,000,000 acres. In Wisconsin it is estimated at from two to three million acres. No estimate is available for Minnesota.

The present standing timber of value will be gone within a relatively short time. In Michigan it is estimated by the timber owners as a decade: in Wisconsin it will be a little longer and in Minnesota State Forester Cox estimates about thirty years for the present saw timber to last.

Such facts point to the necessity of an immediate and extensive plan of reforestation for the great area of land, incapable under present conditions of reproducing valuable species naturally.

CENTRAL HARDWOOD REGION

THIS forest has its principal extent in Ohio, West Virginia, Indiana, Kentucky and Tennessee, a large part of the watershed of the Ohio River and its tributaries. To the west it occupies the southern portion of the Lake States, extending to the prairies, the central part of Missouri and the northwestern part of Arkansas. It dips down into Mississippi, Alabama and Georgia, occupies the Piedmont Plateau east of the Southern Appalachians and extends northeastward into southern New England. For convenience of treatment, that portion lying in the Southern States is discussed with what pertains to the Southern Forest Region.

The Central forest contains the principal supply of hardwood timber and almost all of our broad-leaf, deciduous trees find their best development there—oaks, hickories, ashes, walnut, cherry, tulip poplar, etc. A full description of forest types and forest conditions is not pertinent to a statement concerning commercial planting. Ownership is almost entirely private, much of the timber being in woodlots, excepting in the more thinly settled hill and mountain portions of the region. Exploitation of valuable species, fires and grazing have caused deterioration of the forest on a very large area. Lands have been cleared and farmed that now need reforesting, since their value is greater in forest than as farm land. Interest in commercial planting is greatest in the northeastern part of this region and in Ohio, to a less degree in Indiana and the Lake States, and little interest, if any, in the rest of the region.

SOUTHERN NEW ENGLAND AND MIDDLE ATLANTIC STATES

MARKET conditions in this part of the hardwood region are excellent and, in the aggregate, there is a large area of non-agricultural lands, either open land, brush covered, or occupied by worthless tree species. The chestnut bark disease has killed many chestnut stands, the renewal of which with valuable growth is largely dependent upon planting. Activity of State foresters has brought about a large amount of planting by private owners. The species chiefly used are white pine and some other conifers, on account of their higher yield per acre. Results of some of these plantations have been cited under "Northern Forest" (see p. 14). Timber production is the chief object of planting, growing of fence posts and like materials has been only incidental.

Massachusetts,[*] under its policy of accepting deed to private lands at a purchase price not to exceed $5 per acre and reforesting them, has planted 1,000 acres a year since 1906. Such lands may be redeemed by the owner within 10 years on payment of original price, plus the amount expended in improvements and maintenance, with interest at the rate of 4% per annum on purchase price.

The State Forester of New Jersey emphasizes care and proper management of woodlands rather than extension of wooded areas by planting.[†] The following table, compiled from State Forester Gaskill's report, is a conservative statement of species recommended, and shows their commercial possibilities. A few additional notes have been added.

Species.	*Yield per Acre Bd. Ft., etc.*	*Age Years.*	*Site for Planting.*	*Purpose of Planting.*
[‡]White pine	30,000	50	All soils except poor sand	Timber
[¶]Red (Norway) pine	30,000	60	All soils	Timber
Scotch pine	25,000	50	Any soil, especially for poor soils	Timber
Austrian pine	(Yield less than W. P.)		Poor limestone soils	Timber and box boards
Norway spruce	30,000	60	Cool site, fairly strong soil, not dry	Paper pulp and timber
Douglas fir (Rocky Mt. seed)	25,000	60	Fair soils	Timber
European larch	20,000	60	Fair soils, well drained	Posts and poles
Red oak	700 railroad ties	40	Fair soils	Railroad ties
White ash	10,000	25	Fair soils (moist)	Tool handles
Shellbark hickory	15 cords	25	Moist soil	Vehicle material, tool handles
Pignut hickory	15 cords	25	Drier soil	Tool handles
Tulip poplar	30,000	50	Good, well-drained soils	Finishing lumber, fine box boards
Basswood	Yield less than tulip poplar		Good, well-drained soils	Finishing lumber, fine box boards
[‖] Black locust	2,000 posts	15	All soils except poorest	Posts

Catalpa is not recommended for New England and New Jersey. It needs good soils and a milder climate.

Trees for planting are preferred to direct sowing of seed on the site. The total average costs given by State Forester Gaskill are $7.38 per acre for planting one-year-old deciduous species and $9.09 for three-year-old conifer transplants; spacing 6′ x 6′, and cost of trees $3 per M for the former and $4 for the latter. Examples of expected profit are figured to be 5% or 6% on money invested.

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[*] Massachusetts, Chapter 478, Acts of 1908.

[†] "Forest Planting in New Jersey," by Alfred Gaskill. Reports of the Forest Park Reservation Commission of New Jersey, 1913.

[‡] Massachusetts and Connecticut planting indicates possibility of higher yield.

[¶] Will probably yield nearly as high at 50 years as white pine.

[‖] Subject to attack locally by borers, which often ruin a plantation.

Planting is recommended in Delaware on farms having no woodlots and for protective purposes.* The species recommended are chestnut, red oak and pin oak, tulip poplar, hardy catalpa and black locust. No data of plantations are recorded.

The known area of forest plantations in Maryland is very small. Planting has been recent and principally for the production of fence posts, using catalpa and locust. In one 50-acre plantation† set in 1882-1884, yellow poplar, black walnut, chestnut, red oak, white ash, maples, white pine and a few other species were planted. The cost of planting, if home-grown stock is used, is estimated at $8 per acre. Commercial forest planting has a small place as yet in this State.

Ohio Valley

Under this may be included Ohio, Indiana and Northern Kentucky. One may distinguish in general (1) upland forests, containing oaks, hickories, sugar maple, white ash, tulip poplar, basswood, walnut, cherry and beech; (2) lowland forests of elm, red maple, black ash, sycamore willow, gums, etc. The region is predominantly agricultural, and, for the most part, the forest is found in small detached parcels. Much planting for production of fence posts has been done successfully. The chief species planted have been catalpa, locust and Osage orange. This planting has been profitable, yielding good returns in a short period of years. Climatic conditions are more favorable for growth than in similar operations in the prairie region of the West. Values of land are high, and hence but small areas on farms in the best agricultural sections can be devoted to such planting. Interest in quick-growing species has been stimulated by co-operative assistance of the Agricultural Experiment Station. This has been done with the purpose of creating an interest in the planting of long-lived species for timber production and of encouraging care of woodlots.

‡ The following table gives the average returns from 12 catalpa plantations in 4 counties in Ohio, spacing and site conditions varying much. Their ages ranged from 18 to 28 years.

Number of posts per acre	2,710
Per cent first-class posts	70
Per cent second-class posts	30
Value per acre	$198.59
Average annual increase in value per acre	8.54

The greatest production was 4,780 posts per acre, value $412.80; average annual increase in value, $18.76. The lowest was 1,134 posts, value $97.24; average annual increase, $4.86. The ages of these stands were 22 and 20, respectively.

In southeastern and southern Ohio the topography is more hilly and much waste land is to be found. Planting can be done for commercial production and to hinder erosion on steep hillsides. Southwestern Pennsylvania, southeastern Ohio, West Virginia, Kentucky and Tennessee are underlain in part by bituminous coal. In the localities of the coal mining, the demand for mine props is great, and the local supply is diminishing rapidly in eastern Ohio and southwestern Pennsylvania. Planting of hardwoods, both rapid-growing and longer-lived, together with improved treatment of woodland, is essential to meet future demands. Some expermental planting indicates its commercial value.

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* Bull. 82, Report on Forest Conditions in Delaware. Delaware College Agricultural Experiment Station, Newark, Del., 1908.

† Report of the Maryland State Board of Forestry, 1910-11.

‡ Bull. 204, Forest Conditions in Ohio. Ohio Agricultural Experiment Station, Wooster, Ohio, 1909.

Conditions found in southern Indiana are quite similar to those in the southern counties of Ohio. Woodlot management should be encouraged and planting confined to barren hillsides. The Forestry Department of the Ohio Experiment Station is furnishing planting stock for reforestation. The principal species in the Station nursery are white pine, red pine, Norway spruce, bald cypress, red oak, white ash and tulip poplar.

KENTUCY AND TENNESSEE

THE plateaux and mountains of the eastern portion of these two States have extensive forests, and the problem is one of conservative management. All of our principal hardwood species are to be found in the region. To the west is the central highland region, in which the timber consists of woodlots, wooded slopes and ridges and woodland along streams.* According to R. C. Hall, 32 per cent of the area in this portion of Kentucky and Tennessee is wooded, the chief species being oaks, yellow poplar, beech, chestnut, hickory and red gum. He says: "Forest planting may sometimes be profitable in the central highland region, either to start a new stand or to replace one that has been ruined by heavy logging and repeated fires, or perhaps to utilize old fields and washed lands. On all typical old fields, except those with poorly drained or acid soils, white ash, red oak, and yellow poplar will be found the best trees to plant. On rich, fresh, and moist soil hardy catalpa will do well, and will also furnish a very durable wood. On poor, thin soils black locust is the only tree producing durable wood that will thrive."

The Nashville Basin and the Blue Grass region have 10 to 15 per cent of woodland. No commercial planting is required.

The Mississippi Valley region of Kentucky and Tennessee contains large bodies of forest, but the soils are mainly agricultural, and forest planting will never have much place in the development of this portion of the two States.

OTHER STATES

The hardwood region of the Lake States is agricultural in character. Like Ohio, it is a region of woodlots attached to farms. Reproduction is fair and well-managed woodland is a profitable adjunct to the farm. Planting is chiefly applicable to inferior lands, less valuable or unsuited for agriculture. As a State problem it is minor when contrasted with extensive areas in the northern forest region of the Lake States. Little planting has been done. Both conifers and hardwoods may be utilized. Experimental planting has been done both at the Michigan Agricultural College and at the University of Michigan.

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* AMERICAN FORESTRY, Vol. XIX, No. 8, pp. 533-543.

Conditions in southern Illinois are like those of southern Indiana and Ohio, the problem of planting being the same. At present there is no opportunity for commercial planting in that portion of Missouri, Oklahoma and Arkansas occupied by hardwood forest.

SOUTHERN FOREST REGION

THE problem of forest planting in the South can best be considered under the heads of (1) the upland or Piedmont region; (2) the Atlantic and Gulf Coastal Plain, and (3) the semi-tropical region.

Upland or Piedmont Region

The conditions of the upper, or Piedmont, country extending from Virginia to northern Georgia and westward to the Mississippi River are in several essential points different from those of the coastal plain, comprising a strip approximately 100 miles wide along the shore of the Atlantic and Gulf.

The region is characterized by short-leaf pine forests mixed with oak and hickory, in contrast to the forests of the lower or coastal region, which are essentially of long-leaf and Cuban pine, with a mixture of loblolly pine. This difference is due mainly to climatic and soil conditions, which are dissimilar in the two regions.

The Piedmont, or short-leaf pine, belt comprises the tobacco lands of Virginia and the great cotton-producing region to the south. Throughout this whole region a marked change has taken place in the past 50 years in respect to natural seed regeneration. In former times abandoned fields seeded up fully and rapidly from adjacent seed trees, whereas at present practically all of the first or virgin stand has been cut and the second growth is too young or dense to produce normal seed crops. Abandoned fields are frequently overrun by grass, briars, or underbrush before sufficient pine seed enters. Natural reproduction is consequently much poorer than it was 20 to 50 years ago.

The region is everywhere hilly, and soil erosion due to surface run-off is often excessive and very destructive of the higher valued soils. Natural reforestation of pine, which would otherwise occur, is thus often prevented owing to the lightness of the seed. As a result, tracts of land are not infrequently taken by slow-growing hardwoods of slight or no commercial value. A real forestation problem in preventing excessive soil denudation is present. Furthermore, second-growth pine timber has had practically no stumpage value until within the past five or eight years, hence there was no financial incentive.

Protection to navigable stream courses and conservation of the soil on eroding slopes can best be accomplished by planting the native pines and other commercially valuable forest species. The planting of several species of native pines and hardwoods on deforested and denuded tracts has been very successful during the past 20 years on the Vanderbilt estate near Biltmore, North Carolina. These trees have made vigorous growth and constitute the best proof of the feasibility of forest planting in the South. White pine and short-leaf pine, hard maple, red oak, cherry and other species have been planted either pure or in mixture. The Biltmore estate has approximately 4,000 acres planted with conifers, and 800 acres with hardwoods, a total of 4,800 acres. Planting has been very successful in soil protection, but financial results are yet to be determined.

Lands needing reforestation are not large in the aggregate. Planting is practical and being urged by the State Forester of North Carolina (Holmes) for:

(1) Utilizing abandoned fields, particularly reclaiming eroded fields. The latter is of considerable importance in the hilly uplands of central western parts of the Carolinas.
(2) Protection of watersheds supplying water for towns and cities.

The results to be obtained by such planting are:

1. Production of readily marketable timber, such as pulp wood, or even small saw timber, and material necessary for domestic use, such as fence posts and fire wood.
2. Utilization of otherwise unproductive land.
3. The improvement of land by the prevention of erosion and by the addition of plant food as by planting locust.
4. The protection of the headwaters of streams which are to be used for city water supplies.

There is really an incentive for private planting under these conditions. Short-leaf pine is the one species to be recommended for this region. It is readily handled by direct seed sowing, at a cost of about $4 per acre.

Old field stands in North Carolina yield 10,000 board feet in 30 to 40 years, and 20,000 feet in 45 to 55 years. On average quality sites a conservative calculation shows financial yields of 5 per cent gross, or 4 per cent net profit from plantations. Secondly, the planting of black locust for fence posts on idle or waste lands is practicable.

Private planting will probably not be on an intensive scale as in New England for at least 30 years or more. The State of North Carolina is furnishing advice to private owners in planting, in reference to suitable species, plant material methods of planting and probable returns.

Coastal Plain

A large per cent of the Coastal Plain is forested, although there is very little virgin timber left and second growth mainly composes the forest cover.

Owing to the highly siliceous nature of the soil and lack of mineral plant food, the greater part of the land in the Coastal Plain is more valuable for timber production at the present time than for agricultural purposes. Natural reproduction is prolific, and when fires are excluded for a few years, the young trees reach a height out of danger of further fires. The region is characterized by the long-leaf and loblolly pine flats and hardwood and cypress swamps. The forest problem is chiefly that of protection against fire.

In some instances where close logging and severe fires have left very few seed trees, if any, large tracts may have to be reforested. Loblolly pine grows vigorously throughout this coastal belt and appears to be very successful from direct seeding. The cost of restocking by direct seeding, exclusive of protection, will probably average about $4 per acre. Co-operative experiments started in March, 1912, indicate good results from loblolly and from maritime pines, although he warm winter of 1912-13 was not a satisfactory test for the latter species. Sufficient time has not elapsed to enable definite conclusions to be drawn from hese reforesting experiments. The Forest Service has shown that maritime pine (*Pinus maritima*), the pine of the Landes of the western coast of France, is well adapted to central and northern Florida. Experiments are now being conducted o test its adaptability to the Atlantic Coastal Plain in South Carolina and in New Jersey.

Very little indeed is being done by the States, except the co-operative experiment by South Carolina, and general advice to private owners by North Carolina.

THE SEMI-TROPICAL REGION

The semi-tropical region actually includes only the southern half of the peninsula of Florida, but, in its broader meaning, as used here, practically the whole State is included. The original forest cover included chiefly Cuban and ong-leaf pines among its commercial species, and many small evergreen species of both broad leaf and conifers. Excessive cutting followed by fires, repeated lmost annually, have largely reduced the forest cover on large areas to low brush with scattering trees. The soil is characteristically sandy and generally low in humus.

There is great need of reforesting, but the problem at present is the immediate need of adequate protection against fires.

The climate is sub-tropical, and some of the more exotic tree species of alue commercially are well adapted to this climate. The cork oak (*Quercus uber*), yielding the commercial cork, the camphor tree (*Camphor officinalis*), nd a considerable number of species of eucalyptus rank first in importance of the aluable exotic trees which have been found by test to thrive well in this region.

Eucalypts and camphor have been widely planted by private owners during he past quarter century for ornamental or shade purposes, although no ommercial plantations are known to have been attempted prior to 1907.*

At the present time (1913) there is a very general interest among the settlers n central Florida as far south as Tampa in the forest planting of eucalypts as present asset to their property from a landscape standpoint, and for future eturns in wood of durable and useful qualities. It is impossible to estimate what financial returns may reasonably be expected owing to uncertainty of conditions, particularly market. There can hardly be any such local need of a heavy, urable wood as exists in southern California, because of the favorable conditions n Florida for native forests of pine, oak, and cypress timber.

Eucalypts of many of the hardier species thrive well over all of the Florida peninsula, or north to about the parallel of 30° latitude. Growth is rapid and plantations will furnish large yields of durable wood suitable for ties and posts and of high heating value for fuel. Blue gum (*Eucalyptus globulus*), which is extensively planted in southern California, is not adapted to Florida, except the extreme southern end, on account of its susceptibility to the hard frosts which occur every few years. The most hardly and promising species for Florida are red gum, gray gum, manna gum, red mahogany, red gum tree, and swamp gum.

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* Forest Service Bull. 87, "Eucalypts in Florida," by R. Zon. U. S. Department of Agriculture.

The camphor tree (*Camphor officinalis*) thrives on the better classes of land in all parts of Florida. If conservative methods of securing the resin for commercial purposes are used, the tree should be planted closely in hedge rows clipped for the by-product. If, however, the custom at present prevailing in Japan is followed, of utilizing the entire tree, the camphor may be shown to be suitable for extensive reforestation of badly denuded tracts.

The introduction of cork oak into Florida dates back many years, but the Forest Service in January, 1911, on the Florida National Forest near Pensacola, established the first forest plantation of cork oak in the State. The trees in two seasons from the acorn have reached an average height of 5 to 8 feet, outstripping the rate of growth of all native American oaks. In the unique properties of the bark and much wider climatic range, the cork oak probably has a much greater future commercially than the eucalypts. An experiment in reforesting the higher soils of the coastal plain of South Carolina is under progress by the State in co-operation with the Forest Service. The trees wintered well in 1912-13, and may be found to thrive that far north.

Maritime pine (*Pinus maritima*), the turpentine-producing pine, which the French successfully used in afforesting the sand dunes of the Landes in western France, grows thriftily in nearly all parts of Florida. The oldest plantations were started on the Florida National Forest in the spring of 1910, and the Forest Service now has between 150 and 200 acres of young forest of this pine. It is proposed to increase this acreage during the next two years to about 600 acres in order to make a thorough test of the rate and character of the growth during the first five or ten years, and of the practicability of extensive reforestation with this species. Several thousand acres of burns in the scrub pine forest region on the National Forest in eastern Florida could be converted from a waste area into forest producing high yields of turpentine. The Landes of France in 30 years rose from a value of less than $2 per acre to an average of about $200 per acre by the planting of maritime pine. The original cost of reforesting with maritime pine is probably the lowest in the United States, because of the very small cost of the seed, cheap labor, and the loose sandy character of the soil. In France pine stands are tapped at 25 to 40 years of age, and during the next 20 to 50 years of intermittent cupping yield large net revenues from turpentine and resin. Afterwards, the timber is logged and manufactured. The rapid, vigorous growth of the maritime pine and high resin productivity give it great superiority over the native long-leaf pine for use in artificial reforestation.

THE PRAIRIE REGION

THERE are better opportunities for commercial forest planting in the prairie region than in any other section of the United States except, possibly, New England. This is due, primarily, to the excellent market for fence osts, telephone poles, cordwood and other products. In most portions of the rairie region suitable sites can be found and there are a number of species which re hardy and of rapid growth, and well adapted to be grown on a short rotation or the products chiefly in demand in the region.

There are two general types of planting sites in the prairie region, namely, he Uplands, consisting of exposed, rolling prairies or plains, and the Lowlands, r the bottom lands and slopes of the valleys. The opportunity for commercial lanting on the Uplands throughout the region is practically limited to wind-reaks and small groves around the farm-stead.

In general, the land is well adapted to farming and is too costly for profitable imber production, except where wind-break protection increases agricultural ields sufficiently to pay for narrow strips of land devoted to shelter belts. ingle wind-breaks are less effective and less profitable than belts of deciduous rees 75 to 150 feet wide, or of conifers 50 to 75 feet wide. The direct financial eturns from the products of wind-breaks and shelter belts vary widely, according o climatic and soil conditions, the species planted and the care given the plantaion, especially during its earlier years. Recent investigations in Nebraska showed hat wind-break protection from south winds increased the yield equal in amount o the yield of a strip from an area as long as the wind-break and twice as wide s the height of the trees. The trees in this case were 38 feet high; therefore, a trip of land 75 feet wide could be devoted to a shelter belt at no cost for the and, and the yield of timber from the area would be clear profit, which, in this nstance, was $5.39 per acre per year.

In the Lowlands, the better conditions of soil moisture are more favorable o commercial planting than on the Uplands, except where the soil is extremely lkaline through seepage. Frequently there are areas in the Lowlands of coniderable size which are not adapted to agriculture and are, consequently, low n price—as, for instance, steep bluffs and bottoms subject to frequent overflow. ccordingly, it is in the bottoms that we find the best opportunities for comnercial forest planting on a large scale.

The species recommended for planting, the care of plantations and the returns iffer considerably in various portions of the region. Details can be obtained for particular region through numerous publications issued by the U. S. Departnent of Agriculture, or by the Agricultural Experiment Stations of the several States. Briefly, the Prairie Region consists of three principal divisions, viz:

The Northern Prairie Region, including eastern Montana, the Dakotas, outhern and western Minnesota, and northern Iowa.

The Middle-West, including southeastern South Dakota, Iowa, Nebraska, Kansas, eastern Colorado, and western Illinois.

The Southern Plains, including western Oklahoma, southwestern Kansas, orthwestern Texas, and eastern New Mexico.

THE NORTHERN PRAIRIE REGION

On the Uplands in the Northern Prairie Region there should be a shelter bel along the northern border of every 160-acre farm, another along th western border and two extending from north to south at intervals o 60 rods from the west side. The species recommended for the best soils ar European larch, cottonwood, white willow, Scotch pine and western yellow pine On poor soils or in very exposed situations, western yellow pine, Scotch pine white spruce, green ash, white elm, hackberry, and box elder are the mos desirable. Under-planting with Black Hill spruce or Colorado blue spruce 1 years after the shelter belt is established will be profitable, principally because increases the efficiency of the wind-break. Mixed planting is recommended although it must be done with caution; for pure planting, the use of conifers i advised. A spacing of 4 x 4 or 3 x 6 feet for conifers, 5 x 5 or 4 x 6 for th slower growing deciduous trees, and 6 x 6 feet for cottonwood is recommended Thorough cultivation is necessary until the ground is entirely shaded. Ever four or five years after the sixth or seventh year, the smaller and less promisin trees should be cut out, but such thinnings should be very light, to prevent th growth of grass and weeds. The trees in the shelter belts will not seriousl encroach on the adjoining cultivated land until they are 35 to 40 years old. A this time they will yield a large amount of material suitable for box board rough construction lumber, telephone poles, fence posts (for creosoting) an fuel. If the value of the land is not charged against the plantation, the annua return per acre will range from $5 to $15 per acre per year.

The Lowlands of the Northern Prairie Region offer excellent opportuniti for forest planting for the production of fuel on account of the severe clima and the high price of fuels transported into the region. The deep porous soils o the Lowlands are well adapted to all of the species recommended for the Upland The best species for commercial planting in the Lowlands of the Northern Prair Region are: cottonwood, European larch, Scotch pine, silver maple, white willo Austrian pine and white pine. Cottonwood, on account of its rapid growth, hig yield and great variety of uses is undoubtedly the tree best adapted to botto lands, particularly overflow lands. On a rotation of 35 years cottonwood shoul yield at least 25,000 feet, board measure, per acre and, in addition, a considerab quantity of cordwood. A good quality of overflow land can be purchased at fro $5 to $10 per acre; at this figure, the returns from planting cottonwood shoul be from 5 to 7 per cent, according to conditions. White willow and silver map are also adapted to planting on overflow lands and will yield good returns managed on 15 to 20 year rotation for fuel and fence posts. The average annu net return from eight groves of white willow for fence posts and fuel wa $24 per acre, no interest on the investment being calculated. On the same basi European larch and Scotch pine produce, respectively, a net annual return p acre of $11.93 and $13.35. For the production of fuel and fence posts fo creosoting, a spacing of 4 x 4 to 5 x 5 feet is best. For cottonwood a spacin of 6 x 6 feet is recommended. Cultivation must be given until the ground well shaded, except in particularly favorable locations on overflow lands whe is sometimes not absolutely necessary, although at all times desirable. Thinings should begin early and should be much heavier than on the Uplands.

THE MIDDLE WEST.

The best opportunities for commercial planting in the Prairie Region is in ıe eastern portion of the Middle West, on account of favorable climatic conitions and excellent markets. As in other portions of the Prairie Region, indbreaks and shelter belts will prove commercially profitable on practically ery Upland farm because of greater agricultural yields. The best field for rictly commercial planting is offered in the production of fence posts and fuel, though low-priced, fertile bottom land can be used profitably for the production ties, telephone poles and lumber.

The Uplands. Dual purpose trees for shelter and the production of fence osts and fuel recommended for the most fertile Upland soils of the eastern vo-thirds of this region are hardy catalpa, European larch, cottonwood, Osage ange, while pine and white willow. Osage orange and hardy catalpa are not commended for use north of Central Iowa. With the exception of Osage ange and hardy catalpa, fence posts of the species recommended for commercial anting will have to be creosoted. For sandy lands in the western part of the gion the species recommended are Jack pine, Scotch pine, Western yellow pine ıd red cedar. On better soils in the extreme western part of the region honey cust, Russian mulberry, Osage orange, red cedar, western yellow pine, Austrian ne, Scotch pine, green ash and while elm are recommended.

In the Nebraska national forests western yellow pine has proved the best r the ridge and bottom types; Jack pine for south slopes and Scotch pine for rth slopes. Austrian pine for ridges, south slopes and bottoms, and Norway ne for north shopes are still under test. On the Kansas national forest yellow ne is the most promising conifer for all sites with red fir and Jack pine not oroughly proved, and Austrian pine under test. Of the hardwoods, green ash ıd cottonwood are the most hardy tried. Honey locust holds more promise an the black locust, Osage orange or walnut.

Lowlands. Throughout practically the entire region (except northern Iowa) ırdy catalpa and Osage orange will prove profitable when grown for fence osts on well-drained, fertile bottomlands. For lumber, pulp-wood, box boards, aves, fence posts (creosoted) and fuel, the most profitable species is unubtedly cottonwood; for fuel alone, white willow and silver maple. The three st named species will do well on overflow lands not adapted to agriculture. ıe returns from commercial planting of cottonwood for lumber from bottomnd valued at $5 per acre is estimated at 7 per cent per annum.*

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* "Cottonwood in the Mississippi Valley," Bulletin of the U. S. Department of Agriture, No. 24.

ESTIMATE OF RETURNS FROM A COTTONWOOD PLANTATION.

Rotation 35 years. Yield per acre 29,000 ft. B. M.

Expenses Per Acre.

Interest on investment in land, 7% on $5	$48.38
Taxes, 2c on dollar, 0 first, $4 second, and $5 third decade	10.31
Preparation of site and cultivation of plantation $4.25, 35 years at 7%	45.60
Planting stock and planting $4, 35 years @ 7%	42.71
Total cost	$147.00
Returns—29,400 ft. B. M. @ $5 per M	$147.00

A recent study shows that the greatest returns from cottonwood for lumber production is obtained at the age of 35 years. Cottonwood is coming into favor for the manufacture of paper pulp. The greatest yield of peeled pulp wood per acre is at 13 years, when an average of 3.6 cords per acre per year may be expected, or a total of 47 cords. At 6% the returns from a cottonwood plantation on 13 years rotation for pulpwood are estimated as follows:

ESTIMATE OF RETURNS FROM A COTTONWOOD PLANTATION.

Expenses Per Acre.

Compound Interest on land, $50 per acre, 12 years, @ 6%	$50.60
Intial outlay (preparation of soil $2, stock $150, planting $2.50) $6.00, 12 years at 6%	12.07
Cultivation and pruning $4 per year (for 2 years) $8 @ 6%	15.62
Thinning 8 years $2, 4 years @ 6%	2.52
Taxes 2% on one-half value, 50c per year, 12 years 6%	8.43
Total Cost	$89.24
Returns 47 cords pulp wood at $2 per cord (stumpage)	$94.00

European larch, while pine, black walnut and black cherry, and in the southern portion of the region, Russian mulberry, may prove profitable in commercial plantations in the valleys. It is doubtful, however, whether any species but the cottonwood can be profitably grown on a long rotation for lumber production.

In forming plantations cultivation is essential during the first two to four years after planting. Spacing, in general, should not exceed a distance of 6 x 6 feet and should not be closer than 4 x 6 feet, according to the species used and the site conditions. Thinning should begin early and should be made every five years or oftener.

While the conditions in the Middle West are much more favorable than in either the northern or the southern prairie region, the profits in planting will depend very largely on the selection of the species, and the care which is given the plantation. The cost of establishing a plantation is secondary to choosing the right species and the proper site, since the success of the venture depends largely upon the rapidity of growth. It is evident, however, that the rental of the land and the cost of planting must be kept within reasonable bounds, depending somewhat on the advantages which the site possesses in relation to transportation and market conditions.

THE SOUTHERN PLAINS.

In the southern portion of the Prairie Region, the annual precipitation is so unevenly distributed, and wide areas suffer so frequently from prolonged drouth, that commercial forest planting is limited to favorable sites in the Lowlands. Great care must be exercised in the selection of planting sites and in the choice of species. Protective plantings are even more desirable than in the Northern regions, and will prove highly profitable from the protective standpoint alone. In this region there is practically no native timber to draw upon, and successful plantations for fuel and fence posts have proved to be highly profitable, although the returns varied greatly according to the conditions. Successful forest planting in this region where rainfall is light and irregular and evaporation great, depends very largely upon the proper tillage of the soil.

The Uplands. The southern and western sides of each quarter section should be protected by shelter belts from the dry southwest winds, with belts running east and west at intervals of from thirty to forty rods. Where very low windbreaks are used the distance between the hedges should be reduced.

In the more humid eastern portion of the region cottonwood, green ash, Russian mulberry, Osage orange and white elm will thrive. In certain sections the black locust is practically free from the destructive borers and makes an excellent growth on uplands, and is highly profitable for fence posts. It must be planted with caution, however.

In the very dry western portion of the region there are no species that can be depended upon to survive the occasional prolonged drouths, although dry farming methods of cultivation will do much to assure success. Osage orange appears to be a desirable species for this region, although it should be planted with caution until its adaptation to the particular planting site is determined. Trees of less commercial value which may be planted with a reasonable prospect of successful growth are green ash, red cedar, white elm, black locust, honey locust, Russian mulberry and western yellow pine.

The Lowlands. Better conditions of soil moisture are more favorable to commercial planting in the lowlands, except where the soil is extremely alkaline through seepage. Throughout the region, thorough cultivation for a long period is absolutely essestial to profitable growth, and the products from commercial plantations are apparently limited to fence posts and fuel, since lumber can be transported into the region more cheaply than it can be grown.

The most valuable species for plantations in the Lowlands of this region are hardy catalpa, Osage orange, black locust (in certain regions) and Russian mulberry. The prices of fence posts of these durable woods are such that net profits of from $20 to $25 per acre per year (not reckoning interest on investment) may be expected where the proper sites are chosen. However, with the success of creosoting assured there is a possibility that more rapid growing species of woods adapted to the creosote treatment will prove more profitable. The species best suited for this purpose is cottonwood.

A mixture of species is advisable although with thorough cultivation this is not absolutely essential. The trees should be pruned during the first five years after the plantation is formed. A rotation of 20 years, with thinnings every three to five years, after the seventh or eighth year, appears advisable.

On account of greater expense for cultivation, plantations in this region, under the best conditions, cannot be expected to pay over 5 per cent on the investment, if all items of cost are figured at compound interest.

THE ROCKY MOUNTAIN REGION

THE Rocky Mountain region includes a large portion, or all, of Montana, Idaho, Wyoming, Colorado, Utah, Nevada, Arizona and New Mexico. In the valleys precipitation is insufficient to maintain forest growth. Under dry farming methods, wind-breaks may be grown in some of the wider non-irrigated valleys, where they are needed. This will be a distinct aid to agriculture, but cannot be regarded in any sense as a commercial venture. The irrigated lands are too valuable to be devoted to forest growth except to a very limited extent for shade and shelter.

There is an abundance of low-priced land in the mountains, not well adapted to grazing, that can be profitably used only for the production of forests. However, stumpage prices have not advanced sufficiently to warrant private capital engaging in commercial planting, particularly as planting methods are not yet sufficiently worked out to be certain of results, and the cost of planting is at present prohibitive. The large supply of easily accessible virgin timber means a slow advance in stumpage values, and in the future, government forests will undoubtedly help to maintain stumpage prices at figures too low to be considered by the ordinary investor as offering sufficient returns from planting.

There are many deforested watersheds near the larger centers of population in this region that should be reforested, on account of the necessity of conserving the water supplies and also because these waste lands should be producing revenue. All of the species adapted to planting in the region are of such slow growth, however,—requiring from 125 to 200 years or more for the production of saw timber,—that the returns from reforestation can be expected to pay only a very low per cent on the investment. Even under the best conditions it is not likely that more than 3 per cent on the investment can be obtained on any planting done at the present time, and under adverse conditions planting will be done at a loss. It is therefore a function of the government, both State and National, to finance planting enterprises in the Rocky Mountain region until such time as cheap and satisfactory planting methods have been developed and data is obtained that will justify private capital in investing.

On watersheds close to large cities where the transportation facilities are favorable and the markets for the products are the best, it will undoubtedly be profitable for municipalities to reforest the areas from which they draw their water supply. Municipalities can afford to have money invested for a long period at a low rate, if direct financial returns are sure, and in addition the indirect value of the forest will make it a highly profitable form of investment to them.

In planting watersheds the sites adapted for planting, in order of their desirability, are:

(1) Recent Burns (non-restocking).
(2) Old non-restocking burns.
(3) Scrubby Aspen.
(4) Brush areas, oak, maple, cherry, etc.
(5) Sage brush.
(6) Open grassland.

Owing to its mountainous character and the variation in climatic conditions, it is advisable to consider the broad forest types of the region rather than geographic sub-divisions. The principal forest types in the Rocky Mountain region may be classified as (1) Alpine, (2) sub-Alpine, (3) Lodgepole pine, (4) Red fir, and (5) Yellow pine. The Alpine type comprises the timber line forest at the upper extremity of tree growth. The forests of this type have little or no value except for protection purposes. The sub-Alpine type is the uppermost zone of merchantable timber growth. The chief tree is Engelmann spruce. Growth is so very slow in this type that the returns from forest management are necessarily extremely low. Therefore, like the Alpine type the chief value is for protective purposes, and cannot be considered from the strictly commercial standpoint, since it is the duty of the government to manage such forests for the general welfare, even at a loss.

The Lodgepole pine type occupies chiefly the middle altitudinal zone. Lodgepole pine grows with fair rapidity and scientific management in this type will probably yield a small profit in localities close to good markets. The strip system appears to meet the silvical requirements in this type, although the ease with which natural regeneration is secured makes it practical to use the clear cutting system in many localities. Since 180 years may be regarded as an average rotation for the Lodgepole pine, even natural regeneration under the best conditions, offers little inducement to the average investor.

The Red fir type occupies the lower zone of timber growth in the Rockies, in association with the Yellow pine type, although extending to a somewhat higher altitude. Red fir is a tolerant tree and makes excellent growth on northern exposures, even near the lower limit of tree growth where the precipitation is very light. The wood is durable and has a wide range of uses for posts, mine timbers, ties, lumber, etc. Red fir grows more rapidly than Lodgepole pine and responds more quickly to management. It has been planted successfully by the Forest Service, and on the more favorable sites the seed has been sown successfully. For lumber purposes the red fir requires a rotation of about 150 to 200 years; for railroad ties and fence posts a rotation of 75 to 150 years is required. Near a good market and under exceptionally favorable conditions on a low-priced site, the planting of red fir on a short rotation may appeal to the investor, in the not distant future. However, at the present time, natural regeneration of red fir, by either the selection system of management, or the single seed-tree method, is cheaper than planting, and secures satisfactory results. The cost of various methods of securing adequate reproduction of red fir is estimated as follows:

Planting, $10.25 per acre.
Seed spot sowing, $4.25 per acre.
Single seed tree method, $4.25 per acre.

The yellow pine type, next to the lodgepole, is the most extensive type in the Rocky Mountain region. Commercially, yellow pine is the most important lumber-producing tree of the Rocky Mountains. This species grows naturally under more unfavorable conditions of soil moisture than any other commercial species of the region. It is of fairly rapid growth and does well in plantations, and under very favorable conditions is successfully established by artificial seeding. However, it does not offer the possibilities for commercial planting in this region that are offered by red fir, and therefore its planting on a strictly commercial basis can only be done by the government.

It is possible that the planting of Western white pine in the northern Rocky Mountain region can be considered as a strictly commercial proposition on a par with other forms of long time investment. Commercial planting of white pine is restricted to a very small portion of the Rocky Mountain region, and it is only on very carefully selected sites and under exceptionally favorable conditions which have been fully determined by preliminary investigations that planting of even this species can be considered by any but governmental agencies. It is believed that a mixture of western white pine and western cedar will pay best in the white pine region, although the soil of the region,—owing to the greater annual precipitation in the northern Rocky Mountain region—is very productive and will produce high yields of any of the species which will grow there, including Douglas fir, larch, spruce, yellow pine and lodgepole. Protective plantings, as such, are scarcely needed in the white pine region, which is already well forested. The same is true of the fir-larch region. In the lodgepole region of Montana, however, watershed protection is desirable; for this purpose lodgepole pine is recommended.

The possibility of artificial reproduction in the white pine region is shown in the following estimates, based on data collected by the Forest Service, and compiled by Mr. D. T. Mason.

TABLE

Financial Aspects of Artificial Forestation.

The Lodgepole Region Compared with Other Regions.

Part 1.

REGION	Annual cost per acre administration and protection	Reforestation Cost of success in securing 1200 growing plants per acre	Yield per M. B. M. at 100 years average site	Present stumpage value per M. B. M.	Rate of interest actually earned
Montana— Lodgepole	5¢	$9.00	10.9	$3.00	1 %
Arizona— Yellow pine	3¢	10.00	6.0	3.00	4 %
Idaho— White pine	10¢	7.00	60.0	5.00	3½%

Part 2.

REGION	Interest rate	Total cost of production per acre	Cost of production per M. B. M.	Gross Money Yield	Net Money Yield per acre	To earn given rate of interest can afford to spend to plant	Figure to which stumpage must advance to earn interest rate stated in Column 1
Montana— Lodgepole	2%	80.80	7.42	32.70	48.10	2.36	7.42
	3%	203.20	18.62	32.70	170.50	.12	18.62
Arizona— Yellow pine	2%	81.76	13.62	18.00	63.76	1.19	13.63
	3%	210.20	35.03	18.00	192.20	0.00	35.03
Idaho— White pine	2%	81.80	1.36	300.00	218.10	37.20	1.36
	3%	194.90	3.25	300.00	105.10	12.45	3.25

Part 3.

Results on a Million Acre Forest under above Conditions.
Rotation 100 years. Annually cut and reforest 10,000 acres.

TYPE NATIONAL FOREST	Total annual cost administration and protection	Total annual cost planting	Grand total annual cost	Gross annual revenue	Net annual revenue	Net annual revenue per acre
Montana— Lodgepole	$50,000	$90,000	$140,000	$327,000	$187,000	18.7¢
Arizona— Yellow pine	30,000	100,000	130,000	180,000	50,000	5¢
Idaho— White pine	100,000	70,000	170,000	3,000,000	2,830,000	2.83

In the planting work conducted by the Forest Service it has been found that it is not profitable to plant trees less than 3 years old, one year transplanted. The trees are closely spaced. The planting is done either in holes or by the "slit" method. After planting the trees receive no further care until thinning is required, except that sheep and other grazing animals are excluded from the areas and fires kept out. The cost of planting varies from $7 to $12 per acre for the large projects; on smaller ones it may be much greater.

In some sections excellent results have followed direct seeding, but success by this method is very variable. In the Rocky Mountain region wherever there are seed trees present, natural regeneration is cheaper than artificial regeneration. The only exception to this rule is in the lower forest zone where precipitation is very light, and it is extremely difficult to get adequate reproduction. This applies especially to the yellow pine type in the southern Rocky Mountains.

THE PACIFIC COAST REGION

DOUGLAS FIR TYPE

PRACTICALLY all of the territory west of the Cascade Mountains in Oregon and Washington—the Coast Range, the bottom lands, the foothills, and lower western slopes of the Cascade Mountains—belongs to this type. It was originally, and much of it is still, covered with a solid and very dense forest consisting largely of Douglas fir. With it in greater or less abundance are associated such commercially important species as western hemlock, western red cedar, Sitka spruce, amabilis fir, and grand fir. These species will occupy a minor place, and the management of Douglas fir receive first attention from the forester. This type is now being exploited by lumbermen more than any other type, and is sure to be for many years the most active lumber manufacturing district in the country.

A good deal of the land originally occupied by the heavy forests of this type has been cleared for agricultural use, and still more will be. But there yet remains an enormous area, possibly 10,000,000 acres, in western Oregon and Washington, which is ultimate forest land, i. e., it is too steep, or too stony, to be worth clearing. This area has tremendous possibilities for timber producton, and it is a most important public duty to see that this ultimate forest land be kept perpetually at its maximum degree of forest productivity.

About a third of the ultimate forest land of this type is under the control of the Federal Government and the balance is in the ownership of lumber companies, both large and small, railroads, and individuals. The future of this great region, therefore, devolves quite largely upon the private owner. It is to be expected that the area controlled by the Federal Government will be kept forested so as to produce the maximum amount of forest crops perpetually.

In this region there is an abundance of wood for domestic uses on farms; there is no particular occasion for artificial wind-breaks and shelter belts, and there is no afforestation of naturally treeless land to do. The problem, therefore, is merely to reforest in the best possible fashion the ultimate forest land, as fast as the virgin timber is removed by fire or logging, with a view solely to timber production.

The exigencies of logging with donkey engines in the Douglas fir type are such that some form of clean cutting is quite essential, and this system fits in well with the requirements of the species for an opportunity to germinate in the open on a mineral seed bed, and to develop a pure, even-aged stand. Clean cutting is practiced, therefore, in cutting in this type and usually the slash is burned afterward.

On the private lands now being logged no attention is paid to securing a second crop, and the land is usually abandoned to fire and brush. Sometimes it becomes reforested from solitary cull trees which were left standing, or from adjacent green timber; often it is run over by a second or third fire which effectually prevents it from restocking. On the National Forests this type is so cut as to assure its reforestation by natural means.

All things considered, natural regeneration seems to be preferable to artificial, wherever it can be practiced. Under the following conditions, however, it cannot be used successfully and artificial methods are indicated.

> "1. In very decadent stands, where the Douglas fir is past the seed-bearing age and the forest is given over to hemlock, grand fir, and other secondary species not desired in the next crop, artificial methods must be resorted to in order to secure a second crop of the desired species, Douglas fir. A good many such stands exist in western Washington.
>
> "2. In areas where seed trees are very liable to be wind-thrown if left solitary, it is wisdom to artificially reforest rather than to run a large risk of losing the seed trees before they have seeded up the area. Such areas are not common, but they do occur on certain kinds of soil and in certain exposed situations.
>
> "3. Where *all* the trees in the stand are sound and high grade, and where *every* tree has a high merchantable value, it may be economically more profitable to log every tree and artificially restock the areas than to leave trees of high merchantable value as seed trees. Such a condition as this is rare in the Northwest.
>
> "4. Where it is important to secure a cover at once and it is not policy to wait even a year for the natural reproduction, as on a city watershed, or where the competition of brush is feared, or where erosion is to be guarded against, some method of artificial reforestation, preferably planting, must be resorted to."*

Although reforestation may be accomplished by seed sowing in spots at an average cost of $4.25 per acre, planting is a much surer method. Direct seeding is uncertain and chances for failure are great.

Planting can be done in the most favorably situated localities in such a way as to be successful for $8.50 per acre, but the cost will be greater when the transportation charges for plants and labor are high. The cost per acre on an average accessible tract in this locality will be about as follows, assuming that 681 trees are planted per acre—i. e., that they are spaced 8 feet by 8 feet, the spacing now used on the National Forests:

	Per thousand plants	Per acre 8 x 8 feet
Nursery-grown 1-1 transplants ready for shipment	$4.00	$2.72
Transportation, nursery to planting site	.75	.51
Labor of planting	7.00	4.77
Supervision	1.25	.85
Total	$13.00	$8.85

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* "Natural vs. Artificial Regeneration in the Douglas Fir Region of the Pacific Coast," by Thornton T. Munger. "Proceedings of the Society of American Foresters," VII, 2.

"The practicability of planting is, of course, contingent upon the possibility of securing plants. For large operators or for the Forest Service, which raises its own trees, the cost of the trees is lower than it would be for the small operator who has but a small tract to reforest each year and must buy his planting stock of a commercial nursery, and must run the risk of not being able to get any locally grown nursery stock when he wants it."*

Douglas fir will ordinarily be used pure, except in special cases where it is desirable to use some red cedar, Sitka spruce, white pine or noble fir with it.

In addition to the cut-over areas that require artificial reforestation, there are burns in this type, denuded by severe crown fires, that need artificial treatment. Douglas fir shows a remarkable ability to re-establish a stand after fire, but it is chiefly the second or third fire at short intervals on the same ground that makes artificial planting necessary. The burns will be reforested in the same method that is applicable on cut-over land. It is usually best to plant up a burn as soon as possible, before the brush, which might be a handicap to the plants and to the planting operations, becomes rank.

Though there seems to be a well-nigh inexhaustible supply of virgin timber in the Douglas fir region, and present stumpage prices are very low, yet the field is very attractive to the forester and commercial planting will undoubtedly be profitable, provided a reasonable rise in the value of stumpage is assumed. The following table† indicates the yields of merchantable material that can be expected from the better classes of forest soil in this region (only trees over 12 inches in diameter being included.

Age, Years.	*Feet B. M. per acre.*
50	28,000
60	41,000
70	51,700
80	61,100
90	70,300
100	79,800
110	90,300
120	101,500
130	113,000

A rotation of 60 to 100 years should produce timber of fair size for general purposes, and an even shorter rotation will give good round timber in abundance. The longer rotation would probably be used by the government, while the shortest practicable period would be chosen by the private owner. Periodic thinnings are possible and practicable, provided market conditions are satisfactory, in Douglas fir stands from the time they are 35 or 40 years old.

The following table, quoted from "Practical Forestry in the Pacific Northwest," by Mr. E. T. Allen, is a useful guide in determining the profits from the growing of Douglas fir. It is prepared from the yield table above allowing five extra years, to make it conservative, for the stand to become established:

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* "Natural vs. Artificial Regeneration in the Douglas Fir Region of the Pacific Coast," by Thornton T. Munger. "Proceedings of the Society of American Foresters," VII, 2.

† From Forest Service Circular 175.

	Cost per M of growing Douglas fir resulting from every $1 per acre originally invested		Cost per M of growing Douglas fir resulting from every 1 cent per acre of annual carrying charge	
	At the end of		At the end of	
	60 years	80 years	60 years	80 years
At 4%	$0.30	$0.41	$0.068	$0.098
At 5%	.53	.88	.101	.172
At 6%	.94	1.87	.152	.309

If the original investment is $10.00 per acre ($7.50 for the planting and $2.50 for the land), and the annual carrying charges are 10 cents an acre, this plantation would have cost its owner at the end of 60 years $6.31 per M feet if he figures his investment at 5% ($ .53 x 10 + $ .101 x 10). Hence if he can sell his crop at the end of 60 years, and there is no doubt that he could, for $6.31 per thousand, he would make 5% on his investment, and in addition have the land and the returns from the periodic thinnings.

THE SUGAR PINE TYPE

This is the characteristic type of central and northern California and extreme southern Oregon on the Sierra Mountains, on the Coast Range, and on the cross ranges, and comprises the important timber zone where the moisture and temperature are favorable to a coniferous forest. Not excepting the redwood type it is the timber type of California. Its distinctive component is sugar pine, which occupies from 15% to 50% of the stand. With the sugar pine are found in an exceedingly irregular mixture, western yellow pine, Jeffrey pine, incense cedar, Douglas fir, white fir, and several other species.

Its forests are usually uneven-aged, rather open, and rather brushy. Except for a somewhat different exterior appearance due to the prevalence of sugar pine and incense cedar, the forest resembles strongly the yellow pine type in its silvical characteristics and requirements, and at its geographic limits and on all dry situations within its range it grades into this type imperceptibly.

A considerable proportion of this type, certainly a half of it, lies within the National Forests. The remainder is under private control.

The silvicultural management of the sugar pine type will be very similar to that used for the yellow pine type, i. e., a selection method of cutting with natural reproduction. Ordinarily artificial reforestation will not be necessary in the management of this type, even as an auxiliary to Nature, except on badly deforested burns.

The burns, which are the only field for artificial reforestation in this type, present a difficult problem to the forester on account of the brush or "mock-chaparral" with which they are covered. The brush fields, of which there are in need of reclamation in northern California and southern Oregon, certainly 200,000 acres, are the result of repeated fires which have successively decreased the chances of natural reproduction and increased the density of the brush. There are so many difficulties in reforesting this type that the only method which promises real success is the planting of nursery-grown stock.

This is rather a slow-growing type, probably not exceeding at best 250 board feet per acre per year. Planting, therefore, for the purpose of growing timber would not be a profitable investment for private capital under present economic conditions; artificial reforestation in this type will be practiced only by the government in order to restore waste areas to productivity.

WESTERN YELLOW PINE TYPE

This is one of the most widespread timber types in the country, and in addition to being found in the drier Pacific Coast forests it occurs throughout the Rocky Mountain States. In the Pacific Coast region proper it occurs on the east slopes of the Cascade Mountains in Oregon and Washington, on the interior mountain ranges of these States, on the drier exposures within the white pine region of northern Idaho, and on the California mountains on situations too hot and dry for the sugar pine type. On the east slope of the Cascades it forms a solid belt of timber with an altitudinal breadth of 1,500 feet or so, extending from the desert, or "dry timber line" to the upper slopes, where it gives way to the fir type.

This yellow pine type is the important commercial type within its range, for yellow pine is one of the most useful of the western conifers. In places the stand is practically pure western yellow pine over large areas; in other places there is a varying amount of Douglas fir, lodgepole pine, white fir, grand fir, western larch, and incense cedar. Usually the forest is very uneven-aged, and an abundance of seedlings and saplings, in groups, fills up the gaps in the loose canopy of the older trees. This type occupies a region in which the climate is unfavorable to most tree species and in which growth is ordinarily slow even for yellow pine.

Some of the land within this type is agricultural, but the majority of it is so dry or so cold, or so rocky, or so steep that it should remain forested perpetually and be one of the Nation's sources of lumber. Possibly a half of this type in the Pacific Coast region is within public ownership in the National Forests and Indian Reservations. Most of the rest is held by large lumber companies, and a little is held as a part of ranches or woodlots.

The method of silviculture which is indicated for this yellow pine type, and which is now being put into practice with good success on the National Forests, is a selection method of cutting. As in the sugar pine type, there is practically no occasion to use any method of artificial reforestation in the yellow pine type proper, for the selection method of cutting meets so nicely the silvical requirements of the tree. This type, moreover, is singularly free from disastrous fires, so that seldom is so large an area devasted that it does not become reforested naturally.

LAND BORDERING THE YELLOW PINE TYPE

In the naturally treeless land of central Washington and Oregon, bordering the yellow pine belt, is a ranching region. Here small blocks of trees are very desirable to supply fuel, posts, etc., for local use, to act as wind-breaks, and for their scenic effect. These shelter belts, or woodlots, must be located where they may be irrigated or sub-irrigated, for the climate is usually too dry to grow trees without artificial help. Severe winters and occasional late frosts compel the use of fairly hardy trees. The only practicable method of starting these plantations is by planting nursery-grown stock (or cuttings, in the case of poplars and willows). The spacing will, of course, depend upon the object of the owner and the species to be used. For wind-breaks it would not be wider than 4 x 4 feet, while for fuel purposes with rapid-growing species it might be as wide as 7 x 7 feet. The climate is so variable in this region that the choice of species must be decided locally. In general, frost-hardy, drought-resistant, rapid-growing hardwoods only are desirable. The following seem to meet the requirements of the region—if they can be watered enough to get a start—green ash, box-elder, various species of poplars, black cherry, white willow, white elm, and red oak. In the warmer parts of the Pacific Coast region in southern California, eucalyptus will be used. The usefulness of such planting is very evident, but the profit cannot be estimated. Returns will depend greatly upon local site conditions.

Redwood Type

Though geographically a small and local type, the redwood forest must be considered separately, for it is economically very important and silvically is unlike any of the other types of the country. It occupies a narrow strip along the California coast north of Monterey County and within the "fog belt," i. e., within 25 miles or so of the shore line. Redwood trees which reach a diameter of 5 to 15 feet and sometimes a height of over 300 feet, dominate the stand, though on slopes particularly such species as tanbark oak, white fir, Douglas fir, and western hemlock are numerous.

Redwood produces a good all-purpose wood of ready merchantability. Its stands are extremely heavy and offer an attractive field for the lumberman in spite of the difficulties of handling the giant trees. Logging has been in progress in this type for many years and quite a proportion of the virgin forest has been cut over. A good deal of the original forest land in this type is suitable for farming and will in time be cleared for cultivation or pasturage, but much of it is too steep for agricultural use and should be kept forested. Practically all of the redwood type is in private ownership and most of it is in the hands of large lumber companies. The future of this type, therefore, depends upon the care given it by these private owners.

The customary method of logging redwood is extremely destructive of the forest and leaves it in very bad condition for natural regeneration. After the trees are all felled, the area is burned over by a hot slash fire. The logs are then bucked and hauled out by donkey engines. This process kills most of the young trees, and subsequent uncontrolled slash fires are apt to kill any reproduction that might start later. A very few companies are cutting their timber conservatively and protecting the cut-over land with a view to securing subsequent crops of timber.

Redwood is one of the few conifers that coppice from the stump, and its sprouts are vigorous and will mature into good trees. This characteristic is the key to the forester's management of this type. If logging methods can be modified and fires controlled, the regeneration of the forest after logging can be secured in this way by natural means at low cost. In some stands, however, the original redwood trees are so scattered that the sprouts would be too wide spaced to make a good quality of second growth.

Artificial means, therefore, are in such cases necessary to fill in the gaps. This will be done by planting nursery-grown trees. Redwood is probably the most desirable of any of the native trees for this purpose; one lumber company is using eucalyptus. The number of trees to be planted and the cost of the work will depend wholly upon the number of sprouts already present.

There are also cut-over areas within the redwood type which have been so completely denuded by logging and fire that they must be reforested artificially in order to bring them back to productive condition. Eucalyptus is suggested for this purpose, but it cannot be said yet whether it will be ultimately successful or not.

In "Practical Forestry in the Pacific Northwest," Mr. E. T. Allen says of the redwood type: "Government studies on the northern California coast prove conclusively, however, that this is our most rapid growing native commercial tree. In thirty years, on fair soil, it will produce a tree 16 inches in diameter, 80 feet high, and some 45-year-old stands run 20 to 30 inches on the stump, and about 100 feet high. There is little question of the profit of growing redwood provided the difficulties described elsewhere of getting a dense crop started are overcome." Conservative forest management in this type by any reasonably cheap method of natural or artificial reforestation should be financially profitable to the private owner assuming that the value of stumpage will constantly increase. Second crops of redwood should be of good size for the sawmill in 50 years, and if eucalyptus can be successfully grown on these lands the new forest would be merchantable in even shorter time.

WESTERN WHITE PINE TYPE.

Most of northern Idaho and adjoining small portions of the States of Washington and Montana on the west side of the Continental Divide are occupied by the white pine forest region, and about a half of this area belongs to the white pine type. This forest type occupies the lower slopes of the mountains, which, with its humid and rather mild climate, is pre-eminently adapted to the growth of western white pine. This tree is perhaps the most valuable of the important western conifers, and its propagation will therefore control the forest management in this region. It forms in the virgin woods at least 50% of the stand over large areas, though it is by no means everywhere the dominant tree. Douglas fir, western larch, western red cedar, Engelmann spruce, western hemlock, lodgepole pine, and western yellow pine all occur in greater or less abundance in this region, and on the drier sites a mixture of larch, yellow pine, and Douglas fir takes the place of the white pine type proper.

The white pine forests are usually rather dense, rather uneven-aged, and are composed of trees of medium size. The climate is favorable, and hence growth is rapid, as in the Douglas fir type west of the Cascades.

Quite a large proportion of this type is on land which will eventually be cleared for agricultural use, but a good deal of it, especially most of that within the National Forests, is ultimate forest land. Probably over half of it falls within the National Forests, and the rest is privately owned, except for a few hundred thousand acres within an Idaho State Forest. This region is now the scene of very active logging operations, and it will undoubtedly always be an important timber producing district. This region has the capacity to produce such a large quantity of high value timber that here intensive forest management should be profitable to the individual owner (i. e., the large, stable companies that are in business for an indefinite time), as well as to the government.

Artificial reforestation should be used to supplement natural, and is required for burned lands of which there is a considerable area. The method of artificial reforestation recommended for white pine is like that for the Pacific Coast types—planting of nursery-grown stock. Direct seeding has been so unsuccessful as not to be advisable, and one of the chief causes for its failure seems to be the high mortality the first year during the hot, dry weather.

White pine is the species recommended for general use wherever it naturally reaches good development. With it should be planted a 25% to 50% mixture of other trees as fillers and for an understory—western larch, Engelmann spruces, and western red cedar—since white pine is too intolerant to do well in an absolutely pure stand. The white pine and larch stock should be either 1—2 or 2—1 transplants, while the Engelmann spruce and red cedar should be 2—1. A spacing of 8 x 8 feet is probably ideal for this type when both cost and silvicultural results are considered. If 60% of the plants are white pine and the balance of the other species there would be 408 white pines per acre. An estimate of the cost of establishing such a plantation of mixed species is as follows:

	Per thousand plants	Per acre 8 x 8 feet
Nursery stock ready for shipment, mixed species	$4.25	$2.89
Transportation, nursery to planting site	.50	.34
Labor of planting	6.50	4.42
Supervision	1.25	.85
Total	$12.50	$8.50

It is estimated that this white pine land is capable of producing at least 600 board feet per acre per year. The length of rotation necessary to give timber of a fair commercial size is 120 years, so that plantations made now should yield 75,000 board feet after 120 years. Thinnings would, of course, yield returns somewhat sooner. But even at the relatively large initial cost of planting, the planting of white pine on ultimate forest land is a profitable investment for a long-term concern, when it is considered that its stumpage is steadily and rapidly rising in value. This is one of the few forest types of the West of which this may be said.

The volume growth of white pine stands is probably somewhat less than that in the Douglas fir type, but its wood is of higher value. Therefore the monetary yield from the white pine type should be comparable with that from the Douglas fir type. The tables showing the cost of growing Douglas fir may be used also to determine the profit in growing white pine.

FIR TYPE

The upper slopes of both sides of the Cascade Mountains of Oregon and Washington, the upper slopes of the Sierra Mountains of California above the zonal ranges of the commercial sugar pine forests, and the upper slopes of the Blue Mountains of eastern Oregon, are occupied by a forest which may be called the fir type, because it consists largely of various species of Abies—A. nobilis, amabilis, concolor, lasiocarpa, shastensis, and magnifica.

Practically all the land embraced within the exterior limits of this type was originally and still is forested. Since the most of it lies above the highest climatic contour at which agriculture can be practiced successfully, this type is practically all ultimate forest land. For this reason it is of the greatest economic importance.

Denuded burned lands require reforestation and planting may be occasionally practicable after logging in the place of natural reproduction. Growth is slow in this type and initial cost of reforestation large, hence planting cannot be considered financially profitable. Its chief importance rests upon the necessity of protecting the flow of important streams.

SUB-ALPINE TYPE

There is no commercial forest planting in this type. It is purely a protective forest composed principally of lodgepole pine, Alpine fir, mountain hemlock and white bark pine. It occurs on the high mountains throughout the Pacific Coast region above the fir type and the zone of timber of commercial size.

AFFORESTATION OF TREELESS LAND WITH EUCALYPTS

Most of southern California and a considerable proportion of the low-altitude valleys of northern California are naturally treeless, yet these regions, particularly southern California, are very much in need of trees for several purposes—for timber, for fuel, posts, poles, ties, and lumber; for watershed protection on the mountain sides, for wind-breaks, and for scenic effects about ranches. The problem here, therefore, is the afforestation of desert lands, and it is a problem which has baffled foresters for a number of years and which is still far from being satisfactorily settled. There are several types of treeless land in this great region—chaparral-covered mountain sides at both high and low altitudes, almost vegetationless desert plateaux, and deep-soiled valley land, both irrigable and non-irrigable. No one method of afforestation is, of course, applicable to all these types of land, and care must be exercised to apply the proper treatment on each tract.

The small annual precipitation, its great irregularity, the heat and dryness of the atmosphere, all combine to make the operation of afforestation extremely difficult here. To attain success good judgment in the choice of species and methods and care in the selection of the planting stock are essential. Eucalyptus has been the favorite genus to use in this region in the past few years, and its merits have been advertised widely by commercial real estate and nursery companies. Phenomenal yields have been ascribed to it, and its hardiness and adaptability have been much exaggerated.

At low altitudes throughout California, various species of eucalyptus are planted for shade and ornament, and in southern California are a good many thousand acres of commercial woodlots and of wind-breaks, chiefly of blue gum (*E. globulus*). Eucalyptus planting in California is therefore by no means wholly in the experimental stage. The question is on what sites and under what conditions is it practicable and profitable, and what methods should be used.

First, it may be said that eucalyptus should not be planted where a temperature below 26° F. is experienced, or, to be still safer, where 30° F. is the minimum. Eucalyptus is really successfully planted only where it can be cultivated or irrigated at the start, except possibly in the humid coastal belt or in sub-irrigated valleys. Where it is not irrigated, the water table must be within 12 feet of the surface. This limits the range for commercial planting in arid regions practically to agricultural or semi-agricultural areas. It is a mistake to believe that successful plantations can be established on dry rocky mountain sides. The planting of such sites and of the chaparral-covered slopes has usually met with failure, after repeated attempts with a variety of species.

Even after a favorable site for planting is found, the establishment of the plantation requires more skill and money and consequent care than an ordinary coniferous plantation in a forested region.

Methods: The only method of establishing a plantation is by planting nursery-grown stock. Direct seeding is entirely out of the question. Since many species of eucalypts are good sprouters, subsequent crops will start from the coppice sprouts, so that a plantation, once established, may be kept forested indefinitely.

It is best to grow the plants in seed boxes or flats for a few weeks until they are about two inches tall, then transplant them to individual pots in which they are left for a few months more. They will then be 5 to 7 inches tall, but may be set out in the planting site without disturbing their root systems. This method of pot planting implies that the nursery is close to the planting site. Where it is not, the plants will be transplanted in the nursery in the usual manner.

A year before the field planting is done, it is very desirable to plow the area to get the soil in good condition for the plants. The setting of the trees is done in the usual manner after danger of frost is over and when the ground is moist between January and April. A spacing of 8 x 8 feet is usual for woodlot planting, and 4 x 4 feet in a double row for wind-breaks. The plantation should be cultivated during its first year, as any agricultural crop is, so that it may survive until the roots reach subsoil moisture, and so that it may not be handicapped by weeds.

In woodlot plantations Monterey cypress is often used with eucalyptus with good success; otherwise the plantations are usually pure.

Species: There are hundreds of species of eucalypts, but of these five are particularly worthy of attention by the forester in this region—the blue gum (*E. globulus*), sugar gum (*E. corynocalyx*), red gum (*E. rostrata*), grey gum (*E. tereticornus*), and manna gum (*E. viminalis*). "Whenever the selection of species lies between blue and sugar gum, the kind of product desired and the amount of soil moisture present must determine the choice. If firewood, piles, or dimension stuff is desired, the blue gum should be selected, especially if there is no marked deficiency of soil moisture. If poles, ties, or a wood of unusua durability and strength is desired, the sugar gum should be chosen, particularly if the situation is rather arid. The sugar gum is the more drought-resistant, but the blue gum is the more rapid growing. Outside the planting range of the blue and sugar gums, the red gum commends itself, owing to its frost hardiness and the durability of its timber. In frosty or swampy locations it should receive first preference. The uses of its product are limited, however, by the fact that it is inclined to a crooked, brushy form. It is of rapid growth, and furnishes a product which is very durable in contact with the soil. The grey gum is equally rapid in growth, but is somewhat less frost hardy than the red. It grows in good form, especially in plantations, and furnishes a very durable timber. Manna gum grows very rapidly, but it is hardly worthy of consideration, since it is but slightly more frost hardy than the sugar and blue gums, while its timber is inferior to that of either species."*

Yields and Returns: On proper sites there can be no doubt of the profitableness of commercial eucalyptus planting, contingent, of course, upon a reasonable initial investment for land and planting, intelligent management, and accessibility to market. Areas suitable for eucalyptus planting, that is, near transportation and where the minimum temperature is not less than 24° F., can be purchased for about $30 per acre. The cost of preparing an acre of ground for planting does not ordinarily exceed $6. Seedlings can be purchased for $6 per thousand. The planting of 1,000 trees (enough for an acre) costs about $4. The cost of cultivating and caring for a plantation for two years does not usually exceed $7 per acre, including the purchase of trees to fill blanks in the plantation. Any thinnings made up to the time of the first cutting should pay for themselves. The cost of establishing a plantation and carrying it through the first two years excluding the cost of land, is therefore about $23 per acre.

Taxes on the class of land used for growing blue gum amount to about 30 cents per acre per year. Ten cents per acre per year should be expended in protection from fire. These two items represent a fixed annual charge per acre for the 10-year period before the first cutting. Discounted at 4 per cent, this amounts to a present investment of about $3.25 per acre. The total investment involved in establishing 1 acre of plantation is, therefore, about $56.25.

Actual measurements show that an average yield of about 6.4 standard cords or 8.5 California cords, per acre is produced by the best blue gum groves in the State. Individual groves have occasionally done better. One grove was found which produced 185.9 standard cords in 25 years, or about 7.4 cords per year. Another produced over 59 cords in nine years, or nearly 6.6 cords per year. On he other hand, three groves under average conditions, with fair soil and the water table not more than 25 feet from the surface, show an annual growth per acre of only 4.05, 3.9, and 3.7 cords, respectively. Under unfavorable condiions, with a deep water table or with hardpan near the surface, the annual growth n two cases has been as low as 1.6 cords and 1.1 cords per acre. An annual yield of 6.4 cords per acre, or 64 cords per acre in 10 years, may therefore be accepted as a fair estimate of what may be obtained upon the best sites under he methods of management heretofore used.

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* "Handbook for Eucalyptus Planters," by G. B. Lull, Circular 2, California State Board of Forestry.

Assuming a stumpage price of $2.50 per standard cord, this yield would return $160 in 10 years from the wood alone. This represents nearly 13% compound interest on the original investment of $56.25. Out of that amount $30, the cost of the land, may be considered as restored to the investor with the harvesting of the crop, and is, in effect, an additional return.

Since blue gum sprouts rapidly, the same return of 64 cords, worth $160, should be obtained periodically at the end of every 10 years for at least several rotations. In this case, however, no additional expenditure is necessary for establishing or caring for the plantation. The amount invested is, therefore, $33.25 ($30 for land and $3.25 for capitalized taxes and protection). A return of slightly more than 19% would thus be realized in growing each of the sprout crops following the first, or planted, crop. This is assuming that the value of the and remains unchanged and that this amount is re-invested periodically after each crop is harvested.

In the figures just given it is assumed also that the operation is handled by he individual investor on an area large enough to be managed economically. This should be not less than 50 acres.*

Eucalyptus planting has not solved the problem of the afforestation of the treeless southern California hills, as the more optimistic hoped it would. No tree is superior to the eucalypts for the better class of arid land. The unfavorable chapparal-covered hillsides, however, which have so far resisted all attempts to reforest them with eucalypts and with conifers must probably long remain forestless.

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* "Yield and Return of Blue Gum in California," by T. D. Woodbury. Forest Service Circular 210.

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Returns

The returns vary for different species of trees, but for white pine---which is one of the best trees to plant from a commercial standpoint---figures have been worked out by government and state foresters. These authorities agree that the most profitable time to cut a stand of planted white pine is 40 to 50 years after planting. The value at 50 years on average soil is estimated at 35,000 to 45,000 board feet of lumber per acre. This should have a stumpage value (value of the wood standing) of $200.00 to $400.00 per acre.

Aside from the direct returns realized from the sale of the trees, a timber tract has another value. It is not only valuable in itself, but it increases the value of the farm.

It represents a present profit because it increases the value, not alone of the unproductive land on which it stands, but also of every cultivated acre in the farm. A farm which contains idle land will command a better price if this land is planted with timber than if left bare.

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Planting Distances

Showing the number of trees required per acre from 1 to 30 feet
tance between each tree.

NUMBER OF TREES OR PLANTS ON AN ACRE AT VARIOUS DISTANCES

At 3 feet apart each way.....	4,761	At 12 feet apart each way.....	
At 4 feet apart each way.....	2,729	At 15 feet apart each way.....	
At 5 feet apart each way.....	1,742	At 18 feet apart each way.....	
At 6 feet apart each way.....	1,200	At 20 feet apart each way.....	
At 8 feet apart each way.....	680	At 25 feet apart each way.....	
At 10 feet apart each way.....	430	At 30 feet apart each way.....	

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